Photo by T. C. Turner & Co. — *17, Upper Street, Islington, N.*

J. PATTEN BARBER, M. INST. C.E.

PAST PRESIDENT.

[illegible]

London
E. & F. N. SPON, LIMITED, 57 HAYMARKET.
New York
SPON & CHAMBERLAIN, 123 LIBERTY STREET.
1907

Street

M. Inst. C.E.

Institution of municipal & county engineers, Lond.

PROCEEDINGS

OF THE

INCORPORATED ASSOCIATION OF MUNICIPAL AND COUNTY ENGINEERS

VOLUME XXXIII. 1906-1907

EDITED BY

THOMAS COLE

ASSOC. M. INST. C.E.

(Secretary of the Association)

The Association is not as a body responsible for the facts and opinions advanced herein.

London

E. & F. N. SPON, LIMITED, 57 HAYMARKET.

New York

SPON & CHAMBERLAIN, 125 LIBERTY STREET.

1907

LONDON: PRINTED BY WILLIAM CLOWES AND SONS, LIMITED,
GREAT WINDMILL STREET, W., AND DUKE STREET, STAMFORD STREET, S.E.

CONTENTS.

Memorandum of Association

OF

THE INCORPORATED ASSOCIATION OF MUNICIPAL AND COUNTY ENGINEERS.

1. The name of the Association is "THE INCORPORATED ASSOCIATION OF MUNICIPAL AND COUNTY ENGINEERS."

2. The Registered Office of the Association will be situated in England.

3. The objects for which the Association is established are:

(a) The promotion of the science and practice of engineering applied to the health and improvement of counties and towns, and rural districts.

(b) The promotion of the professional interests, rights, powers, and privilèges of county, urban and rural engineers, the improvement of their professional status, and the extension and interchange of professional knowledge and practice.

(c) The acceptance of any gift, endowment or bequest, made to the Association, and the carrying out of any trusts attached to any such gift, endowment, or bequest.

(d) The examination of persons in engineering, surveying, building construction, sanitary science and works, and in local government, municipal and sanitary law; and the granting of certificates of having passed the examination in the above subjects to candidates. Provided that no such certificate be granted without a note on it stating that "This Certificate shows the result of an Examination held on behalf of the Association, and is not to be deemed a qualification to discharge the duties of any office or appointment."

(*e*) The constitution of two classes of members, viz. Members and Graduates; and, when thought proper, the election of persons distinguished in connection with Municipal Engineering or in Sanitary Science, as Honorary Members.

(*f*) Subject to the provisions of the 21st section of The Companies Act of 1862, the acquisition and disposal of lands and property for the objects aforesaid.

(*g*) The doing all such lawful things as are incidental or conducive to the attainment of the above objects.

4. The income and property of the Association, whencesoever derived, shall be applied solely towards the promotion of the objects of the Association as set forth in this Memorandum of Association; and no portion thereof shall be paid or transferred, directly or indirectly, by way of dividend, bonus, or otherwise howsoever, by way of profit to the Members of the Association. Provided that nothing herein shall prevent the payment in good faith, of remuneration to any officers or servants of the Association, or to any Member of the Association, or other person, in return for any services actually rendered to the Association.

5. The fourth paragraph of this Memorandum is a condition on which a Licence is granted by the Board of Trade to the Association, in pursuance of section 23 of the Companies Act, 1867.

6. If any Member of the Association pays or receives any dividend, bonus, or other profit, in contravention of the terms of the fourth paragraph of this Memorandum, his liability shall be unlimited.

7. Every Member of the Association undertakes to contribute to the Assets of the Association, in the event of the same being wound up during the time that he is a Member, or within one year afterwards, for payment of the debts and liabilities of the Association contracted before the time at which he ceases to be a Member, and of the costs, charges, and expenses of winding up the same, and for the adjustment of the rights of the contributories amongst themselves, such amount as may be required, not exceeding one pound, or in case of his liability becoming unlimited, such other amount as may be required in pursuance of the last preceding paragraph of this Memorandum.

8. If upon the winding up or dissolution of the Association

there remains after the satisfaction of all its debts and liabilities, any property whatsoever, the same shall not be paid to or distributed among the Members of the Association, but shall be given or transferred to some other institution or institutions having objects similar to the objects of the Association, to be determined by the Members of the Association at or before the time of dissolution, or in default thereof by such Judge of the High Court of Justice as may have or acquire jurisdiction in the matter.

9. True accounts shall be kept of the sums of money received and expended by the Association and the matter in respect of which such receipt and expenditure takes place, and of the property, credits and liabilities of the Association; and, subject to any reasonable restrictions as to the time and manner of inspecting the same that may be imposed in accordance with the regulations of the Association for the time being, shall be open to the inspection of the Members. Once at least in every year the accounts of the Association shall be examined, and the correctness of the Balance Sheet ascertained, by one or more properly qualified Auditor or Auditors.

We, the several persons whose names are subscribed, are desirous of being formed into an Association in pursuance of this Memorandum of Association.

Names, Addresses, and Descriptions of Subscribers.

H. Percy Boulnois, M.Inst.C.E., City Engineer, Liverpool.
E. Pritchard, M.Inst.C.E., Birmingham.
E. R. S. Escott, M.Inst.C.E., Borough Surveyor, Halifax.
T. De Courcy Meade, A.M.Inst.C.E., Surveyor to the Local Board, Hornsey.
W. Santo Crimp, A.M.Inst.C.E., District Engineer, London County Council.
A. W. Parry, A.M.Inst.C.E., Borough Surveyor, Reading.
T. Walker, A.M.Inst.C.E., Borough Surveyor, Croydon.

Dated the 13th day of September, 1890.

Witness to the above signatures,

Thomas Cole, A.M.Inst.C.E.,
Secretary.

11, Victoria Street,
London, S.W

Articles of Association

OF

THE INCORPORATED ASSOCIATION OF MUNICIPAL AND COUNTY ENGINEERS.

Introduction.

WHEREAS an Association called the "Association of Municipal and Sanitary Engineers and Surveyors" (hereinafter referred to as the "existing Association"), has long existed for objects similar in many respects to the objects expressed in the Memorandum of the Association to which these Articles apply (hereinafter called "the Association"), and the existing Association consists of Members, Graduates, and Honorary Members, and is possessed of Books, Drawings, and Property used for the objects aforesaid;

AND WHEREAS the Association is formed for furthering and extending the objects of the existing Association, by a registered Association, under the Companies Acts, 1862 to 1866; and terms used in these Articles are intended to have the same respective meanings as they have when used in those Acts, and words implying the singular number are intended to include the plural number, and *vice versâ*.

Now, therefore, it is hereby agreed as follows:—

Constitution.

1. For the purpose of registration, the number of Members of the Association is declared to be five hundred, but the Council may at any time register an increase of Members as occasion shall require.

Members.

2. The subscribers of the Memorandum of Association, and such other persons as shall be admitted in accordance with these Articles, and none others, shall be Members of the Association, and be entered on the Register as such.

3. Any person may become a Member of the Association who, being a Member of the existing Association, shall agree to transfer his Membership of the existing Association, and all rights and obligations incidental thereto, to the Association, and to be registered as a Member of the Association accordingly.

4. Any person may become a Member of the Association who shall be qualified and elected, as hereinafter mentioned, and shall agree to become such Member, and shall pay the entrance fee and first subscription accordingly.

5. The rights and privileges of every member of the Association shall be personal to himself, and shall not be transferable or transmissible by his own act or by operation of law.

Qualification and Election of Members.

6. The qualification of Members shall be prescribed by the Bye-laws from time to time in force, as provided by the Articles.

7. The election of Members shall be conducted as prescribed by the Bye-laws from time to time in force, as provided by the Articles.

Associate Members, Associates, Graduates, and Honorary Members.

8. Any person may become an Honorary Member or Graduate of the Association who, being already an Honorary Member or Graduate of the existing Association, shall agree to transfer his interest in the existing Association, and all rights and obligations incidental thereto, to the Association.

9. The Association may admit such other persons as may be hereafter qualified and elected in that behalf as Associate Members, Associates, Graduates, and Honorary Members respectively of the Association, and may confer upon them such

privileges as shall be prescribed by the Bye-laws from time to time in force, as provided by the Articles.

10. The qualification and mode of election of Associate Members, Associates, Graduates, and Honorary Members shall be prescribed by the Bye-laws from time to time in force, as provided by the Articles.

10A. Except for the purposes of Article 25, an Associate Member shall be deemed to be a Member within the meaning of these Articles, but no Associate, Graduate, or Honorary Member shall be deemed to be a Member within the meaning of these Articles.

Entrance Fees and Subscriptions.

11. The Entrance Fees and Subscriptions of Members, Associate Members, Associates, and Graduates shall be prescribed by the Bye-laws from time to time in force, as provided by the Articles; and the form of request for admission to the class of Members, Associate Members, Associates, or Graduates shall contain a reference to such Subscriptions. Provided that no Entrance Fee shall be payable by a Member or Graduate of the existing Association.

Expulsion.

12. If any Member, Associate Member, Associate, or Graduate shall leave his subscription in arrear for two years, and shall fail to pay such arrears within three months after a written application has been sent to him by the Secretary, his name may be struck off the List of Members, Associate Members, Associates, or Graduates, as the case may be, by the Council at any time afterwards, and he shall thereupon cease to have any rights as a Member, Associate Member, Associate, or Graduate, but he shall nevertheless continue liable to pay the arrears of subscription due at the time of his name being so struck off:

Provided always that this regulation shall not be construed to compel the Council to remove any name if they shall be satisfied the same may be retained.

13. The Council may refuse to continue to receive the subscriptions of any person who shall have wilfully acted in contravention of the lawful regulations of the Association, or who shall in the opinion of the Council have been guilty of

such conduct as shall have rendered him unfit to continue to belong to the Association, and may remove his name from the List of Members, Associate Members, Associates, Graduates, or Honorary Members (as the case may be), and such person shall thereupon cease to be a Member, Associate Member, Associate, Graduate, or Honorary Member (as the case may be) of the Association. Provided that notice shall be given to the offending person, and opportunity of explanation given to him, before his name is removed from the aforesaid List.

General Meetings.

14. The first General Meeting shall be held on such day within four months of the Registration of the Association as the Council shall determine. Subsequent Meetings shall consist of the Annual General Meeting and Special Meetings as hereinafter defined.

15. The Annual General Meeting shall take place in June or July of every year, at such place as the Council shall determine.

16. A Special Meeting may be convened at any time by the Council, and shall be convened by the Secretary whenever a requisition signed by twenty Members of the Association, specifying the object of the Meeting, is left with the Secretary.

If for fourteen days after the delivery of such requisition a Meeting be not convened in accordance therewith, the Requisitionists or any twenty Members of the Association may convene a Special Meeting in accordance with the requisition. All Special Meetings shall, unless otherwise determined by the Council, be held in London.

17. At least seven clear days' notice of every Meeting, specifying generally the nature of any special business to be transacted at any Meeting, shall be given to every Member of the Association, and no other special business shall be transacted at such Meeting; but the non-receipt of such notice shall not invalidate the proceedings of such Meeting. No notice of the business to be transacted (other than such Ballot Lists as may be requisite in case of Elections) shall be required in the absence of special business.

18. Special business shall include all business for transaction at a Special Meeting, and all business for transaction at every other Meeting with the exception of the reading and confirmation of the Minutes of the previous Meeting, the election of

Members, Associate Members, Associates, and Graduates, and the reading and discussion of communications as prescribed by the Bye-laws, or any regulations of the Council made in accordance with the Bye-laws.

PROCEEDINGS AT GENERAL MEETINGS.

19. Thirty Members shall constitute a Quorum for the purpose of a Meeting of the Association.

20. If within thirty minutes after the time fixed for holding the Meeting, a Quorum is not present, no Meeting shall be held, and all matters which might, if a Quorum had been present, have been done at a Meeting (other than a special Meeting) so dissolved, may forthwith be done on behalf of the Meeting by the Council.

21. The President shall be Chairman at every Meeting, and in his absence one of the Vice-Presidents; and in the absence of all Vice-Presidents a Past-President or a Member of the Council shall take the Chair; and if no Past-President or Member of Council be present and willing to take the Chair, the Meeting shall elect a Chairman.

22. The decision of a Meeting shall be ascertained by show of hands, unless, after the show of hands, a poll is forthwith demanded, and by a poll when a poll is thus demanded. The manner of taking a show of hands or a poll shall be in the discretion of the Chairman, and an entry in the Minutes, signed by the Chairman, shall be sufficient evidence of the decision of the Meeting. Each Member shall have one vote and no more. In case of equality of votes the Chairman shall have a second or casting vote, provided that this Article shall not interfere with the provisions of the Bye-laws as to election by ballot.

23. The acceptance or rejection of votes by the Chairman shall be conclusive for the purpose of the decision of the matter in respect of which the votes are tendered, provided that the Chairman may review his decision at the same Meeting if any error be then pointed out to him.

BYE-LAWS.

24. The Bye-laws set forth in the Schedule to these Articles, and such altered and additional Bye-laws as shall be added or substituted as hereinafter mentioned, shall regulate all matters by the Articles left to be prescribed by the Bye-laws, and all

matters which, consistently with the Articles, shall be made the subject of Bye-laws. Alterations in, and additions to, the Bye-laws, may be made only by resolution of the Members at an Annual General Meeting, on the recommendation of the Council, or after notice of motion for such purpose, and the general tenor of the proposed resolution thereon has been sent to the Secretary on or before the 1st of May preceding the date of the Annual General Meeting, and such recommendation or notice of motion and resolution shall be printed in the Agenda for the ensuing Annual General Meeting:

Provided that no regulation shall be made or altered by a Bye-law which, if any, could only be legally imposed by Article of Association, or added or altered by a Special Resolution.

COUNCIL.

25. The affairs of the Association shall be governed by a Council who shall be chosen from the Members only, and shall consist of one President, three Vice-Presidents, fifteen Ordinary Members of Council, Honorary Secretary, Honorary Treasurer, six Past-Presidents, and the District Honorary Secretaries for the time being.

26. The President, Vice-Presidents, Ordinary Members of the Council and one Past-President who is an elective Member of Council, shall retire at each Annual General Meeting, but shall be eligible for re-election.

27. The election of a President, Vice-Presidents, and Members of the Council, including Past-Presidents who are elective Members thereof, shall be conducted in such manner as shall be prescribed by the Bye-laws from time to time in force.

28. The Council may supply any casual vacancy in the Council (including any casual vacancy in the office of President) which shall occur between one Annual General Meeting and another, and the President or Members of the Council so appointed by the Council shall retire at the succeeding Annual General Meeting. Vacancies not filled up at any such Meeting shall be deemed to be casual vacancies within the meaning of this Article.

OFFICERS.

29. The Secretary, Officers, and Servants of the Association shall be appointed and removed in the manner prescribed by the

Bye-laws from time to time in force, as provided by the Articles. Subject to the express provisions of the Bye-laws, the Secretary, Officers, and Servants of the Association shall be appointed and removed by the Council.

30. The powers and duties of the Secretary and Officers of the Association shall (subject to any express provision in the Bye-laws) be determined by the Council.

Powers and Procedure of Council.

31. The Council may regulate their own procedure, and delegate any of their powers and discretion to any one or more of their body, and may determine their own quorum. If no other number is prescribed, three Members of Council shall form a quorum.

32. The property of the existing Association shall be acquired by the Association, and the Council shall manage and administer the property, proceedings and affairs of the Association, in accordance with the Bye-laws from time to time in force.

33. The Council may from time to time invest, in the name of the Association, any moneys not immediately required for the purposes of the Association, in Stocks, Funds, or Securities in which Trustees are by law for the time being authorised to invest.

34. No act done by the Council, which shall receive the express or implied sanction of the Members of the Association in General Meeting, shall be afterwards impeached by any Member of the Association on any ground whatsoever, but shall be deemed to be an act of the Association.

District Committees.

35. District Committees of the Association may be formed, and District Secretaries appointed, in accordance with the Bye-laws for the time being of the Association, and there shall be referred to such Committees all such local or other business and matters as the Bye-laws for the time being shall prescribe, or as may be specially referred to them or any of them by the Council; but the acts and Resolutions of the District Committees shall not be binding upon the Association unless approved of by the Council. Ten Members shall constitute a Quorum of a District Committee.

Examinations.

36. The Council may hold Examinations of persons in Engineering, Surveying, Building Construction, Sanitary Science and Works, and in Local Government, Municipal, and Sanitary Law, in accordance with the Bye-laws for the time being of the Association, and they may grant Certificates of competency in the above subjects to Candidates.

Notices.

37. A notice may be served by the Council of the Association upon any Member, Associate Member, Associate, Graduate, or Honorary Member, either personally or by sending it through the post in a prepaid letter addressed to such Member, Associate Member, Associate, Graduate, or Honorary Member at his registered place of abode.

38. Any notice, if served by post, shall be deemed to have been served at the time when the letter containing the same would be delivered in the ordinary course of the post, and in proving such service it shall be sufficient to prove that the letter containing the notice was properly addressed, and put into the post office.

39. No Member, Associate Member, Associate, Graduate, or Honorary Member, not having a registered address within the United Kingdom, shall be entitled to any notice; and all proceedings may be had and taken without notice to such Member, Associate Member, Associate, Graduate, or Honorary Member in the same manner as if he had had due notice.

Names, Addresses and Descriptions of Subscribers.
H. Percy Boulnois, M.Inst.C.E., City Engineer, Liverpool.
E. Pritchard, M.Inst.C.E., Birmingham.
E. R. S. Escott, M.Inst.C.E., Borough Surveyor, Halifax.
T. De Courcy Meade, A.M.Inst.C.E., Surveyor to the Local Board, Hornsey.
W. Santo Crimp, A.M.Inst.C.E., District Engineer, London County Council.
A. W. Parry, A.M.Inst.C.E., Borough Surveyor, Reading.
T. Walker, M.Inst.C.E., Borough Surveyor, Croydon.

Dated the 13th day of September, 1890.

Witness to the above signatures,

Thomas Cole, A.M.Inst.C.E.,
Secretary.

11, Victoria Street,
London, S.W.

SCHEDULE.

BYE-LAWS.

Membership.

1. Members, Graduates, and Honorary Members of the existing Association may, upon signing and forwarding to the Secretary a claim according to Form F in the Appendix, become Members, Graduates, or Honorary Members respectively of the Association, without election or payment of entrance fees.

Members.

2. Members shall comprise every person who on the 1st May, 1902, was registered as a Member; and every person thereafter elected or transferred to the class of Members. Every Candidate for election or transfer to the class of Members shall be not less than twenty-five years of age, and shall come within the following conditions:

(*a*) He shall have undergone a recognised course of instruction for a Civil Engineer and Surveyor, and shall hold a chief permanent appointment as an Engineer and Surveyor under a Municipal Corporation, County Council, Urban or Rural District Council, or a Public Authority of the like nature.

(*b*) He shall also have passed the examination of the Incorporated Association of Municipal and County Engineers, or he shall be a Member or an Associate Member of the Institution of Civil Engineers, or shall have passed the examination for the Associate Membership of the Institution of Civil Engineers, or shall hold such a degree or diploma in Engineering from an University or other Educational Body, or shall possess such other engineering qualifications as, in the opinion of the Council of the Association, are deemed equivalent to one of the before-mentioned qualifications.

Associate Members.

2A. Every Candidate for election to the class of Associate Members shall be not less than twenty-five years of age, and shall come within the following conditions:

(*a*) He shall have undergone a recognised course of instruction for a Civil Engineer and Surveyor, and shall hold such an engineering appointment as may be approved by the Council or an important Deputy- or Chief-Assistantship, under a Municipal Corporation, County Council, Urban or Rural District Council, or a Public Authority of the like nature.

(*b*) He shall also have passed the examination of the Incorporated Association of Municipal and County Engineers, or he shall be a Member or an Associate Member of the Institution of Civil Engineers, or shall have passed the examination for the Associate Membership of the Institution of Civil Engineers, or shall hold such a degree or diploma in Engineering from an University or other Educational Body, or shall possess such other Engineering qualifications as, in the opinion of the Council of the Association, are deemed equivalent to one of the before-mentioned qualifications.

No person shall be elected or remain an Associate Member who shall be qualified for election as a Member.

Associates.

2B. Every Candidate for election to the class of Associates shall be not less than twenty-five years of age, and shall come within the following conditions:

(*a*) He shall have undergone a recognised course of instruction for a Civil Engineer and Surveyor, and shall hold a position as an Engineering Assistant, or Resident Engineer upon engineering works of magnitude, under a Municipal Corporation, County Council, Urban or Rural District Council, or a Public Authority of the like nature.

(*b*) He shall also have passed the examination of the Incorporated Association of Municipal and County

Engineers, or he shall be a Member or an Associate Member of the Institution of Civil Engineers, or shall have passed the examination for the Associate Membership of the Institution of Civil Engineers, or shall hold such a degree or diploma in Engineering from an University or other Educational Body, or shall possess such other Engineering qualifications as, in the opinion of the Council of the Association, are deemed equivalent to one of the before-mentioned qualifications.

No person shall be elected or remain an Associate who shall be qualified for election as a Member or Associate Member.

GRADUATES.

3. Every Candidate for election to the class of Graduates shall be not less than twenty-two years of age, and shall have passed the examination of the Incorporated Association of Municipal and County Engineers.

No person shall be elected or remain a Graduate who shall be qualified for election as a Member, Associate Member, or an Associate.

HONORARY MEMBERS.

4. The Council shall have the power to elect as Honorary Members gentlemen of eminent scientific position or acquirements, who in their opinion are eligible for that position.

MEMBERS, ASSOCIATE MEMBERS, ASSOCIATES, GRADUATES, AND HONORARY MEMBERS.

5. Members, Associate Members, Associates, Graduates, and Honorary Members shall be entitled to attend all Meetings of the Association, to take part in the proceedings thereof, and to receive a copy of the Minutes of Proceedings. No Associate, Graduate, or Honorary Member shall be entitled to vote, and no Associate Member, Associate, Graduate, or Honorary Member shall be entitled to hold any office, or to be a Member of the Council.

5A. Any Member, Associate Member, or Associate ceasing to hold a permanent appointment or position of the nature described in Bye-laws 2, 2A, and 2B, as the case may be, shall

cease to belong to the Association, but may be re-elected annually in April by the Council. Provided that the foregoing shall not apply to re-elections made by the Council prior to July 1, 1907. No Member so re-elected shall be a Member of the Council or hold any Office in the Association other than that of Hon. Secretary or Hon. Treasurer.

ENTRANCE FEES AND SUBSCRIPTIONS.

6. An Entrance Fee of £1 11*s.* 6*d.* shall be paid by each Member, except Members of the existing Association, who shall pay no Entrance Fee. Each Member shall pay an Annual Subscription of £1 11*s.* 6*d.*

6*a*. An Entrance Fee of £1 5*s.* shall be paid by each Associate Member, except those holding the testamur of the Association, who shall pay no Entrance Fee. Each Associate Member shall pay an Annual Subscription of £1 5*s.*

7. An Entrance Fee of £1 1*s.* shall be paid by each Associate, except those holding the testamur of the Association, who shall pay no Entrance Fee. Each Associate shall pay an Annual Subscription of £1 1*s.*

Each Graduate shall pay an Annual Subscription of 15*s.*

7*a*. No Entrance Fee shall be payable by any person on transfer.

8. Entrance Fees shall be paid within one month after notification of election has been given to the persons from whom they are due. All Subscriptions shall be payable in advance, and shall become due on the 1st of May in each year. Members, Associate Members, Associates, and Graduates elected between the 1st day of January and the 1st day of May next ensuing, shall pay the Entrance Fees as aforesaid, but their first Subscription shall not become due until the 1st day of May following their election.

9. The Council may, at their discretion, reduce or remit the Annual Subscription, or the Arrears of Annual Subscription, of any Member who shall have been a Subscribing Member of the Association for ten years, and shall have become unable to continue the Annual Subscription provided by these Bye-laws.

10. No Ballot List shall be sent to any Member or Associate Member who shall be in arrear with his Subscription more than twelve months, and no Minutes of Proceedings shall be sent to any Member, Associate Member, Associate, or Graduate

so in arrear, and no such Member, Associate Member, Associate, or Graduate shall be entitled to attend any Meeting of the Association. Provided that this rule shall not apply to any Member whose Subscriptions shall have been remitted by the Council as hereinbefore provided.

Election of Members, Associate Members, Associates, and Graduates.

11. A recommendation for admission according to Form A in the Appendix, shall be forwarded to the Secretary, and by him be laid before the next meeting of the Council.

The recommendation must be signed by not less than five Members, who, from personal knowledge of such Candidate, shall certify that he possesses the necessary qualification. Candidates residing outside the United Kingdom not known by five Members of the Association, may be proposed by five Corporate Members of the Institution of Civil Engineers.

All elections of Members, Associate Members, Associates, and Graduates of the Association shall be made by the Council, and shall be decided by a majority of votes of the Members of the Council present and voting.

12. When the proposed Candidate is elected, the Secretary shall give him notice thereof according to Form C; but his name shall not be added to the List of Members, Associate Members, Associates, or Graduates of the Association until he shall have paid his Entrance Fee and First Annual Subscription as defined by these Bye-laws.

Transfer of Associate Members, Associates, and Graduates.

13. A qualified Associate Member, Associate, or Graduate desirous of becoming a Member, Associate Member, or Associate (as the case may be) shall forward to the Secretary a recommendation according to Form D in the Appendix, signed by not less than two Members, which shall be laid before the next meeting of the Council for their approval. On their approval being given, the Secretary shall notify the same to the Candidate according to Form E.

Election of President, Vice-Presidents, and Members of Council.

14. The Council shall nominate one name for President, three for Vice-Presidents, one for Honorary Secretary, one for Honorary Treasurer, and eighteen for Ordinary Members of Council. In addition to these each Member of the Association shall be at liberty to nominate one Member for the Council, but in the event of the nominations by Members of the Association exceeding twelve the Council shall reduce them to that number, so as to leave thirty names in all from which to elect the required number of Ordinary Members of Council. Should the Members of the Association not exercise their privilege of nominating twelve names, then the Council may increase the number of their nominations for ordinary Members of Council, providing the total nominations do not exceed thirty in all. Members' nominations must be received by the Secretary not later than the 1st of February in each year. The names of those nominated shall be printed on Ballot Papers, one of which shall be sent to each Member of the Association entitled thereto not less than fourteen days previous to the Annual Meeting. Each Member receiving a Ballot Paper shall be entitled to vote for or erase any of the names thereon and to substitute others, subject in all cases to the limits of Clause 25 in the Articles of Association; such Ballot Paper must be returned to the Secretary and received by him not later than seven days from the date of issue. The returned Ballot Papers shall be examined at the Offices of the Association by the President, Secretaries, and the Scrutineers appointed at the previous Annual Meeting.

A Past-President shall be ex-officio a Member of the Council during the three years next after the date of his ceasing to be President.

There shall also be three other Past-Presidents elected by ballot by the Council as Members of Council. Such Past-Presidents shall be Members of Council for three years, and one shall retire each year. The election of a Past-President to fill the place of the retiring Past-President shall take place annually at the meeting of the Council at which the Council for the ensuing year are to be nominated. At the first election one of such Past-Presidents shall be elected a Member of Council

for one year only, one for two years only, and one for three years.

Any Member of the Association canvassing for votes for the office of Member of Council shall be ineligible for election.

Appointment and Duties of Officers.

15. The Treasurer shall hold the uninvested funds of the Association, except the moneys in the hands of the Secretary for current expenses. He shall be appointed by the Members at a General or Special Meeting, and shall hold office at the pleasure of the Council.

16. The Secretary and Assistant-Secretary of the Association shall be appointed by the Council, and shall be removable by the Council upon three months' notice from any day. The Secretary or Assistant-Secretary, if desirous of resigning his appointment, shall give the same notice. The remuneration of the Secretary and Assistant-Secretary shall from time to time be fixed by the Council.

17. It shall be the duty of the Secretary and Assistant-Secretary under the direction of the Council, to conduct the correspondence of the Association; to attend all General and Special Meetings of the Association and of the Council, and of Committees (but not the District Meetings, unless required so to do by the President): to take minutes of the proceedings of such meetings; to read the minutes of the preceding meetings, and all communications that they may be ordered to read; to superintend the publication of such papers as the Council may direct; to direct the collection of the subscriptions, and the preparation of the account of expenditure of the funds; and to present all accounts to the Council for inspection and approval, and generally to do all such other matters as usually pertain to the office of Secretary, or as may be prescribed by the Council.

Examinations.

18. Two or more examinations of Candidates for certificates of competency in Municipal Engineering, Surveying, Building Construction, Sanitary Science, and Municipal Law, shall be held annually at such places and at such times as the Council shall appoint.

The Board of Examiners shall be not less than twelve in number, and shall be elected by and be Members of the Council, or such other Members of the Association as shall be leading men in their particular branch of the engineering profession. Four or more of such Board shall be selected by the Council to carry out each examination, who as "Acting Examiners," shall report to the Council the names of those Candidates who have satisfied them of their proficiency.

MISCELLANEOUS.

19. All communications to the meetings shall be the property of the Association, and be published only by the authority of the Council.

20. Seven clear days' notice at least shall be given of every meeting of the Council. Such notice shall specify generally the business to be transacted by the meeting.

21. The Council shall present the yearly accounts to the members at the Annual General Meeting, after being audited by two auditors, who shall be appointed annually by the Members at the Annual General Meeting.

22. No Member, Associate Member, Associate, or Graduate shall use the initial letters of the name, or any abbreviation of the name, of the Association to indicate his connection therewith.

23. Notwithstanding anything contained in these Bye-laws, persons who on the 23rd day of November, 1903, were Members or Associates of the Scottish Association of Municipal and County Engineers (in this Bye-Law called the Scottish Association) shall not be required to pay an Entrance Fee upon becoming Members or Associates of the Association, and in the case of such persons, being members of the Scottish Association, the Council may dispense with the provision of Bye-Law 2 requiring Members to hold a chief permanent appointment, and in the case of such persons, being Associates of the Scottish Association, the Council may dispense with the provision of Bye-Law 2B, requiring Associates to be twenty-five years of age.

APPENDIX.

Form A (for Election).

THE INCORPORATED ASSOCIATION OF MUNICIPAL AND COUNTY ENGINEERS.

To the Council of the Association.

I__________of__________born on the______day of______ 18______, desire to belong to the Incorporated Association of Municipal and County Engineers, as a______________(*class to which election is desired to be filled in*), and I do hereby promise that in the event of my election I will be governed by the Articles, Bye-laws, and Regulations as they are now formed, or as they may be hereafter altered, amended, or enlarged, that I will pay the Entrance Fee and Subscription prescribed for the Class to which I may be elected by the Articles and Bye-laws for the time being in force, and that I will promote the objects of the Association as far as may be in my power.

Witness my hand this__________day of__________19__

*Signature*____________________

*Scholastic training*____________________

*Technical training*____________________

*Present position*____________________

On the above grounds, we, the undersigned, from personal knowledge propose Mr.__________to the Council as being in every respect a proper person to belong to the Association.

____
____
____________________ } *Signatures of at least Five Members of the Association.*
____
____

Form C.

THE INCORPORATED ASSOCIATION OF MUNICIPAL AND COUNTY ENGINEERS.

SIR,

I have to inform you that at a Council Meeting held on the ________day of__________19__you were elected__________ of the Incorporated Association of Municipal and County Engineers.

I am, Sir,

Your obedient servant,

____

Secretary.

Form D (for Transfer).

THE INCORPORATED ASSOCIATION OF MUNICIPAL AND COUNTY ENGINEERS.

To the Council of the Association.

I___ ____ of___________born on the_____ day of______ 18____, at present a__________of the Incorporated Association of Municipal and County Engineers, desire to be transferred to the class of__________, and I do hereby promise that, in the event of my transfer, I will be governed by the Articles, Bye-laws, and Regulations as they are now formed, or as they may be hereafter altered, amended, or enlarged, that I will pay the Subscription prescribed for the class to which I may be transferred by the Articles and Bye-laws for the time being in force.

Witness my hand this__________day of__________19____

Signature ____________

Name in full ____________

Address ____________

Technical training ____________

Present position ____________

On the above grounds we, the undersigned, from personal knowledge, propose Mr.____________to the Council as possessing the qualifications necessary for his transfer.

____________ *Signatures of at least Two Members of the Association.*
____

Form E.

THE INCORPORATED ASSOCIATION OF MUNICIPAL AND COUNTY ENGINEERS.

Sir,

I have to inform you that at a Council Meeting held on the ____ day of ________19___you were transferred from the class of _____to that of_______of this Association.

I am, Sir,

Your obedient servant,

____

Secretary.

Form F.

THE INCORPORATED ASSOCIATION OF MUNICIPAL AND COUNTY ENGINEERS.

*Address*______________________________

*Date*______________________________

As a [*Member*, *Graduate*, or *Honorary Member*] of the Association of Municipal and Sanitary Engineers and Surveyors, I claim to become a [*Member*, *Graduate*, or *Honorary Member*] of the Incorporated Association of Municipal and County Engineers. And I hereby agree to transfer my Membership in the Association of Municipal and Sanitary Engineers and Surveyors, and all rights and obligations incidental thereto to the Incorporated Association of Municipal and County Engineers.

Please to register my name accordingly.

*Signature*______________________________

To

THE SECRETARY
of the Incorporated Association of
Municipal and County Engineers.

Form F¹ for Election under Bye-law 23.

THE INCORPORATED ASSOCIATION OF MUNICIPAL AND COUNTY ENGINEERS.

I____________of____________born on the______day of______ 18____, holding the appointment of__________________enclose herewith the sum of [*for Members*] £1 1*s*. [*for Associates*] 15*s*., being my first Annual Subscription, and I desire that my name may be added to the list of [*Members*] or [*Associates*] of the Incorporated Association of Municipal and County Engineers.

[*Undertaking to be signed by the Candidate.*]

I do hereby promise that I will be governed by the Articles, Bye-laws, and Regulations of the Association as they are now formed, or as they may hereafter be altered, amended, or enlarged; and that I will promote the objects of the Association as far as may be in my power.

*Signed*______________________________

COUNCIL, 1907-1908.

President.

JOHN A. BRODIE, M. Eng., Wh. Sc., M. Inst. C.E., City Engineer, Liverpool.

Vice-Presidents.

W. N. BLAIR, M. Inst. C.E., Borough Surveyor, St. Pancras.
E. P. HOOLEY, M. Inst. C.E., County Surveyor, Nottingham.
C. F. WIKE, M. Inst. C.E., City Surveyor, Sheffield.

Ordinary Members of Council.

C. H. COOPER, M. Inst. C.E., Borough Engineer, Wimbledon.
H. A. CUTLER, M. Inst. C.E., City Surveyor, Belfast.
A. FIDLER, M. Inst. C.E., Borough Engineer, Northampton.
A. D. GREATOREX, M. Inst. C.E., Borough Surveyor, West Bromwich.
W. HARPUR, M. Inst. C.E., City Engineer, Cardiff.
T. W. A. HAYWARD, A.M. Inst. C.E., Borough Surveyor, Battersea.
P. H. PALMER, M. Inst. C.E., Borough Surveyor, Hastings.
J. PATON, Borough Engineer, Plymouth.
J. S. PICKERING, M. Inst. C.E., Borough Engineer, Cheltenham.
W. H. PRESCOTT, A. M. Inst. C.E., Surveyor Urban Dist. Council, Tottenham, N.
R. READ, Assoc. M. Inst. C.E., City Surveyor, Gloucester.
H. E. STILGOE, M. Inst. C.E., City Engineer, Birmingham.
R. J. THOMAS, M. Inst. C.E., County Surveyor, Bucks.
H. T. WAKELAM, M. Inst. C.E., County Engineer, Middlesex.
A. E. WHITE, M. Inst. C.E., City Engineer, Hull.

Past Presidents.

A. T. DAVIS, M. Inst. C.E., County Surveyor, Salop.
A. E. COLLINS, M. Inst. C.E., City Engineer, Norwich.
J. PATTEN BARBER, M. Inst. C.E., Borough Engineer, Islington.

Elective Past Presidents.

O. C. ROBSON, M. Inst. C.E., Surveyor, Urban District Council, Willesden, N.W.
T. H. YABBICOM, M. Inst. C.E., City Engineer, Bristol.
J. LOBLEY, M. Inst. C.E., Borough Engineer, Hanley.

Honorary District Secretaries.

African District.—H. F. PEET, M. Inst. C.E., City Engineer, Bloemfontein.
Eastern District.—J. W. COCKRILL, M. Inst. C.E., Great Yarmouth.
Home District.—S. H. CHAMBERS, Hampton-on-Thames.
Indian District.—J. HALL, M. Inst. C.E., Bombay.
Irish District.—R. H. DORMAN, M. Inst. C.E., Armagh.
Lancashire and Cheshire District.—C. BROWNRIDGE, M. Inst. C.E., Birkenhead.
Metropolitan District.—W. F. LOVEDAY, Borough Surveyor, Stoke Newington.
Midland District.—H. RICHARDSON, A. M. Inst. C.E., Handsworth, Birmingham.
Northern District.—J. P. DALTON, Ryton-on-Tyne.
Scottish District.—J. BRYCE, Assoc. M. Inst. C.E., Partick, N.B.
Wales (North).—W. JONES, Assoc. M. Inst. C.E., Colwyn Bay.
" (South).—W. E. C. THOMAS, Assoc. M. Inst. C.E., Neath.
Western District.—T. MOULDING, Assoc. M. Inst. C.E., Exeter.
Yorkshire District.—H. W. SMITH, Assoc. M. Inst. C.E., Scarborough.

General Hon. Secretary.

CHAS. JONES, M. Inst. C.E.

Honorary Treasurer.

LEWIS ANGELL, M. Inst. C.E.

Secretary.

THOMAS COLE, Assoc. M. Inst. C.E., 11 Victoria Street, London, S.W.

Assistant Secretary.

HENRY A. GILES, 11 Victoria Street, London, S.W.

Telegraphic Address:
"Bisecting, London."

Telephone Number:
"Westminster 5083."

PAST PRESIDENTS.

1873–4 / 1874–5	LEWIS ANGELL, M. Inst. C.E.
1875–6.	*J. G. LYNDE, M. Inst. C.E.
1876–7.	JAMES LEMON, M. Inst. C.E.
1877–8.	*F. ASHMEAD, M. Inst. C.E.
1878–9.	G. F. DEACON, LL.D., M. Inst. C.E.
1879–80.	*E. PRITCHARD, M. Inst. C.E.
1880–1.	*A. W. MORANT, M. Inst. C.E.
1881–2.	*W. S. TILL, M. Inst. C.E.
1882–3.	C. JONES, M. Inst. C.E.
1883–4.	W. H. WHITE, M. Inst. C.E.
1884–5.	*W. G. LAWS, M. Inst. C.E.
1885–6.	*R. VAWSER, M. Inst. C.E.
1886–7.	J. LOBLEY, M. Inst. C.E.
1887–8.	*J. GORDON, M. Inst. C.E.
1888–9.	E. B. ELLICE-CLARK, M. Inst. C.E.
1889–90 / 1890–91	H. P. BOULNOIS, M. Inst. C.E.
1891–2.	T. DE C. MEADE, M. Inst. C.E.
1892–3.	J. CARTWRIGHT, M. Inst. C.E.
1893–4.	J. T. EAYRS, M. Inst. C.E.
1894–5.	A. M. FOWLER, M. Inst. C.E.
1895–6.	*E. R. S. ESCOTT, M. Inst. C.E.
1896–7.	*F. J. C. MAY, M. Inst. C.E.
1897–8.	Sir ALEX. R. BINNIE, M. Inst. C.E.
1898–9.	O. C. ROBSON, M. Inst. C.E.
1899–1900.	W. HARPUR, M. Inst. C.E.
1900–01.	*C. H. LOWE, M. Inst. C.E.
1901–02.	E. GEORGE MAWBEY, M. Inst. C.E.
1902–03.	T. H. YABBICOM, M. Inst. C.E.
1903–04.	W. WEAVER, M. Inst. C.E.
1904–05.	A. T. DAVIS, M. Inst. C.E.
1905–06.	A. E. COLLINS, M. Inst. C.E.
1906–07.	J. PATTEN BARBER, M. Inst. C.E.

* Deceased.

LIST OF MEMBERS.

IT IS PARTICULARLY REQUESTED THAT EVERY CHANGE OF ADDRESS MAY BE COMMUNICATED WITHOUT DELAY TO THE SECRETARY.

* *Those Members against whose names a star is placed have obtained the Certificate of the Association.*

R *signifies re-election under By-law 5a.* G *elected as Graduate.* A *elected as Associate.* AM *elected as Associate Member.* TA *transferred to Associate.* TAM *transferred to Associate Member.* T *transferred to Member.*

P *signifies recipient of Association's £10 premium.*

P „ „ „ £5 *premium.*

p „ „ „ £3 *premium.*

HONORARY MEMBERS.

Date of Election and Transfer.		
1897 Oct. 16	BECHMANN, G.	Ingénieur en chef des Ponts et Chaussées, Paris.
1898 Dec. 17	BICKNELL, R. H., M. Inst. C.E.	Local Government Board, Whitehall, S.W.
1888 Mar. 3	CODRINGTON, THOS., M. Inst. C.E.	5 Riverdale Rd., Twickenham Park.
1904 Feb. 27	COWAN, P. C., M.Inst.C.E.	Chief Engineering Inspector, Local Government Board, Ireland.
1905 Sept. 23	HAWKSLEY, CHARLES, M. Inst. C.E.	30 Great George Street, S.W.
1892 Apr. 23	PUTZEYS, E.	Ingénieur en chef, Directeur de la Ville de Bruxelles.
1890 Sept. 13	ROBINSON, PROFESSOR HY., M. Inst. C.E.	Parliament Mansions, Westminster, S.W.
1874 June 1	TULLOCH, MAJOR H., C.B., R.E.	28 Victoria Street, S.W.
1904 Jan. 23	WILLCOCKS, G. W., M. Inst. C.E.	Chief Engineering Inspector, Local Government Board, Whitehall, S.W.

MEMBERS.

1893 Oct. 21	ABRAHAMS, C. V.	City Surveyor, Kingston, Jamaica.
1894 June 21 R1902 Mar. 22	ABURROW, C., M. Inst. C.E...	515 Consolidated Buildings, Johannesburg, S.A.
1903 May 16	ADAMS, A. E...	Borough Engineer, Chippenham, Wilts.
1896 Jan. 18	AITKEN, T., M. Inst. C.E. ..	County Surveyor, Cupar, Fife.
1897 Jan. 16	ALLEN, A. T...	Surveyor to the Urban District Council, Portslade-by-Sea, Sussex.
1873 May 2 R1884 Jan. 26	*ALLEN, T. T...	Broad Street, Stratford-on-Avon.
1897 June 19	ALVES, G.	Surveyor to the Urban District Council, Glastonbury.

Date of Election and Transfer.		
1890 June 26	Anderson, R. S., Assoc. M. Inst. C.E.	County Surveyor, Peebles, N.B.
1900 Dec. 15	Anderson, W. V., Assoc. M. Inst. C.E.	City Surveyor, Winchester.
1906 Apr. 28	Andrew, J.	Burgh Surveyor, Dunoon, N.B.
G1898 June 30 T1899 Oct. 21	*Andrews, S. P.	Borough Surveyor, Faversham.
G1894 Oct. 20 T1899 Oct. 21	*Angel, R. J., M. Inst. C.E. ..	Borough Surveyor, Bermondsey, S.E.
1894 May 19	*Angell, J. A., A.M.Inst.C.E.	Surveyor to the Urban District Council, Beckenham, S.E.
1873 Feb. 15	ANGELL, LEWIS, M. Inst. C.E. (*Past President, and Hon. Treasurer.*) (*Member of Council.*)	"Calside," Carlisle Road, Eastbourne.
1899 June 29	*Anstee, J.	Surveyor to the Rural District Council, Guildford.
1880 May 27 R1899 Feb. 25	Armistead, R., Assoc. M. Inst. C.E.	8 Charles Street, Bradford.
1900 June 16	Asquith, A.	Surveyor to the Urban District Council, Holyhead.
1890 June 26	Atkinson, J., A.M. Inst. C.E.	Borough Surveyor, Stockport.
1904 Aug. 4	Atkinson, T. R.	County Surveyor, Earlston, Berwickshire, N.B.
1897 Feb. 13 R1905 Sept. 23	Baff, C. J.	Council Chambers, Gosforth, Newcastle-on-Tyne.
1904 Jan. 23	Baines, C. O.	Surveyor to the Urban District Council, Paignton.
1900 Feb. 10	Bains, G. S. L.	Surveyor to the Urban District Council, Saltburn-by-the-Sea.
1884 May 29	Baker, F.	Borough Surveyor, Middlesbrough, Yorks.
1891 Aug. 1 R1903 Feb. 21	Baker, J., A.M. Inst. C.E. ..	75 High Street, Slough.
1896 June 25	Baldwin, L. L., A.M. Inst. C.E.	Surveyor to the Urban District Council, Coalville, Leicester.
G1891 Aug. 1 T1896 Feb. 22	*Ball, B., A.M. Inst. C.E. ..	Borough Surveyor, Nelson, Lancs.
G1887 Sept. 17 T1898 Feb. 19	*Ball, G., A.M. Inst. C.E. ..	Surveyor to the Urban District Council, Bexhill.
1879 Oct. 23	Banks, W., A.M. Inst. C.E.	City Surveyor, Rochester.
1905 Apr. 29	Barber, E. H., A.M.Inst.C.E.	Town Surveyor, Goole.
1887 Mar. 12	BARBER, J. PATTEN, M. Inst. C.E. (*Past President.*) (*Member of Council.*)	Borough Engineer, Islington, N.
1903 June 25	Barclay, J.	13 Fairlawn Grove, Chiswick.
G1901 Aug. 24 T1906 Apr. 28	*Barker, H. W.	Surveyor to the Urban District Council, Walmer.
G1888 Sept. 15 T1892 July 11	*Barnes, S. W. J., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, Hanwell.
1897 Jan. 16	Barrett, E. J., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, Staines.
1899 Jan. 21	Barrs, J. D.	Surveyor to the Urban District Council, Bromyard.

Date of Election and Transfer.		
G1903 Jan. 17 T1905 May 27	*BATE, E. M.	Surveyor to the Urban District Council, Frinton-on-Sea.
1896 Oct. 24 R1904 May 28	BAYLIS, T. P., Assoc. M. Inst. C.E.	Surveyor, Droitwich.
G1901 June 8 T1903 July 25	*BEACHAM, W. E.	Town Surveyor, Leek.
1903 May 16	BEAN, J. A.	County Surveyor, Northumberland. Moot Hall, Newcastle.
1894 Jan. 13	BEAUMONT, A.	County Surveyor, Yorks, East Riding. County Hall, Beverley.
1897 Mar. 13	BEAUMONT, G. E.	Surveyor to the Rural District Coun., Wortley. "Holme Lea," Greenoside, near Sheffield.
1897 Mar. 13	BEAUMONT, T. C.	Surveyor to the Rural District Council, Driffield.
1892 Jan. 16	BELL, G., Assoc. M. Inst. C.E.	Borough Surveyor, Swansea.
1897 Jan. 16	BELL, G. J., M.Inst.C.E. ..	County Surveyor, Cumberland. Carlisle.
A1902 Jan. 25 T1906 Dec. 15	*BELL, L. M., M.Inst.C.E. ..	Municipal Engineer, Penang, S.S.
1906 Apr. 28	BELL, T. H.	Surveyor to the Urban District Council, Ramsbottom.
1895 Jan. 19	BELLINGHAM, A. W. H., M. Inst. C.E.	Engineer-in-Chief, British Municip., Tientsin, North China.
1896 Jan. 18	BENNETT, H. M.	Surveyor to the Rural District Council, Keynsham, Bristol.
1886 Dec. 18 R1902 Nov. 8	BENNETT, W. B. G., M. Inst. C.E.	Midland Bank Chambers, Southampton.
G1898 Dec. 17 T1900 July 19	*BENNETTS, J. P.	Surveyor to the Urban District Council, Harrow.
1886 Oct. 16 R1896 Jan. 18	BERRINGTON, R. E. W., M. Inst. C.E.	Graisley, Wolverhampton.
1892 Mar. 11 R1899 May 6	BESWICK, W. H., Assoc. M. Inst. C.E.	214 Astley Street, Dukinfield, Cheshire.
1891 June 6	BETTANY, F.	Borough Engineer, Burslem.
1902 Mar. 22	BIBBEY, T.	Surveyor to the Urban District Council, Audley. Cheadle, Staffs.
1890 Mar. 29	BINNIE, SIR A. R., M. Inst. C.E. (*Past President.*)	9 Gt. George Street, Westminster, S.W.
1896 Nov. 28	BIRD, W. F.	Surveyor, Midsomer Norton.
1897 Jan. 16	BIRKS, E.	Highway Surveyor to Rural District Council, Uxbridge.
1901 Feb. 16	BLACKBURN, J.	Surveyor to the Urban District Council, Soothill Upper.
P1873 May 2	BLACKSHAW, W., Assoc. M. Inst. C.E.	Borough Surveyor, Stafford.
1904 Aug. 5	BLACKWOOD, R.	Burgh Surveyor, Kilmarnock, N.B.
1886 June 12	BLAIR, W. N., M. Inst. C.E. (*Vice-President.*)	Borough Surveyor, St. Pancras.
1903 Oct. 17	BLAND, J. D.	Surveyor to the Urban District Council, Chesterton.
1907 Apr. 27	BLANEY, C.	Borough Surveyor, Newry, Ireland.
1900 Mar. 10	BLOOD, A. T.	Surveyor to the Urban District Council, Hitchin.
1907 May 25	BODDIE, C. L.	County Surveyor, Londonderry.

Date of Election and Transfer.		
1902 Nov. 8	Borg, E. A.	Borough Surveyor, Margate.
1895 Jan. 19 R1903 Feb. 21	Botterill, C., A.M.Inst.C.E.	583 Fulham Road, Walham Green, S.W.
1904 Feb. 27	Bottomley, H.	Surveyor to the Urban District Council, Bingley.
1877 May 1	BOULNOIS, H. P., M. Inst. C.E. (*Past President.*)	Local Government Board, Whitehall, S.W.
1903 Dec. 12	Bourne, J.	Surveyor to the Urban District Council, Rawmarsh.
1898 Mar. 19 R1903 Feb. 21	Bowen, H. W.	District Surveyor, East Sussex County Council, Kingsley, Hassocks, Sussex.
1904 Aug. 12	Bowie, J. McL.	Burgh Surveyor, Maxwelltown, Dumfries, N.B.
1898 Feb. 19 R1907 Mar. 2	Bowles, A. R., Assoc. M. Inst. C.E.	104 Sandgate Road, Folkestone.
1898 Oct. 15	Boyle, J. C., A. M. Inst. C.E.	City Surveyor, Armagh.
1903 May 16	Bradley, A. W., A.M.Inst.C.E.	Borough Engineer, Bury, Lancs.
G1889 May 18 T1898 Apr. 22	*Bradley, J. W., M. Inst. C.E.	City Engineer, Westminster, S.W.
1897 Jan. 16	Bradley, W. L.	Surveyor to the Urban District Council, Tonbridge.
G1894 Jan. 13 T1896 Oct. 24	*Bradshaw, F. E. G.	Borough Surveyor, Tamworth.
1873 May 2	Bressey, J. T.	Surveyor to the Urban District Council, Wanstead, Essex.
1891 Aug. 1	Brett, J. H.	County Surveyor, Co. Antrim. Belfast, Ireland.
1891 Aug. 1	Brettell, W. H.	Surveyor to the Urban District Council, Rowley Regis, Staffordshire.
1894 Oct. 20	Bridges, O. A.	Surveyor to the Urban District Council, Bognor.
1891 Mar. 21	Brierley, J. H., A. M. Inst. C.E.	Borough Surveyor, Richmond, Surrey.
1901 Dec. 7	BRODIE, J. A., M. Eng., Wh. Sc., M. Inst. C.E. (*President.*)	City Engineer, Liverpool.
1889 Apr. 13	Brodie, J. S., A.M. Inst. C.E.	Borough Engineer, Blackpool.
1905 Dec. 9	Brooke, E.	Surveyor, Lichfield.
1894 Oct. 20	Brooke, J.	Surveyor to the Urban District Council, Northwich, Cheshire.
1884 July 10	Brown, A., M. Inst. C.E. ..	Borough Engineer, Nottingham.
1898 Jan. 15	Brown, C., A. M. Inst. C.E...	Borough Engineer, Chelmsford.
1904 Aug. 25	Brown, Chas.	Burgh Surveyor, Hawick, N.B.
1905 Jan. 28	Brown, F.	Town Engineer, Kroonstad, O.R.C., South Africa.
1905 Sep. 23	Brown, H. H. Lane, M. Inst. C.E.	Supervising Engineer, Lucknow, United Provinces, India.
1881 June 18 R1904 Jan. 23	Brown, J. W., M. Inst. C.E.	Church Square, West Hartlepool.
G1894 July 7 T1898 Sept. 8	*Brown, R., A.M. Inst. C.E.	Surveyor to the Urban District Council, Southall Norwood.
1889 Feb. 9 R1898 Jan. 15	*Brown, R. R.	Electrical Engineer to the Urban District Council, Bridlington.

Date of Election and Transfer.		
1893 Mar. 4	*Brownridge, C., M. Inst. C.E. (*Member of Council.*)	Borough Engineer, Birkenhead. *Hon. Secretary*, Lancashire and Cheshire District.
1904 Aug. 9	Bruce, J. S.	Burgh Surveyor, Kirriemuir, N.B.
1901 Feb. 16	Bryce, J., A.M. Inst. C.E. (*Member of Council*).	Burgh' Surveyor, Partick, N.B. *Hon. Sec.*, Scottish District.
e1889 Feb. 9 T1902 Mar. 22	*Bryning, W. G.	County Surveyor, Northallerton, Yorks.
1873 May 2	Buckham, E., M. Inst. C.E.	Borough Surveyor, Ipswich.
1897 July 8 R1902 Mar. 22	Buckley, M. J., Assoc. M. Inst. C.E.	26 Bessborough Terrace, N.C.R., Dublin.
1897 Feb. 13	Bull, H. F., A.M. Inst. C.E.	County Surveyor, Cheshire.
1895 Feb. 16	Bunting, T. F.	Borough Surveyor, Maidstone.
1895 Jan. 19	Burden, A. M., Assoc. M. Inst. C.E.	County Surveyor, Kilkenny.
1892 Sept. 24	Burgess, S. E., M. Inst. C.E.	Borough Engineer, South Shields.
1900 Apr. 21	Burkitt, J. P., A.M.Inst.C.E.	County Surveyor, Enniskillen.
1905 Mar. 3	Burn, W., A. M. Inst. C.E...	Surveyor to the Urban District Council, Sutton-in-Ashfield, Notts.
1904 Aug. 6	Burns, D.	Burgh Surveyor, Pollokshaws, N.B.
1890 June 7	Burslam, R.	Borough Surveyor, Congleton.
e1895 Jan. 19 T1902 Jan. 25	*Burton, A., A.M. Inst. C.E.	Borough Engineer, Stoke-on-Trent.
1897 Jan. 16	Busbridge, T. A.	Surveyor to the Rural District Council, Spilsby.
e1899 June 29 TA1902 Jan. 25 T1904 Feb. 27	*Bush, W. E., A. M. Inst. C.E.	City Engineer, Auckland, New Zealand.
1890 Sept. 13	Butler, W.	Surveyor to the Urban District Council, Fareham.
1899 June 29	Butterworth, A. S., Assoc. M. Inst. C. E.	Municipal Engineer, Port Elizabeth, S. Africa.
e1905 Dec. 9 T1907 Apr. 27	*Butterworth, G. L.	Surveyor to the Rural District Council, Isle of Thanet.

1894 Apr. 6	Caine, T., Assoc.M.Inst. C.E.	City Engineer, Worcester.
1891 Dec. 12 R1903 Jan. 17	Cairncross, T. W., Assoc. M. Inst. C.E.	Bd. of Exors. Buildings, c/o Wale, Adderley Street, Cape Town, S.A.
1903 Jan. 17	Calder, W., A. M. Inst. C.E.	City Engineer, Prahran, Victoria.
1891 Oct. 17	Campbell, A. H., M. Inst. C.E.	Engineer and Surveyor, Town Hall, East Ham, E.
1887 Mar. 12	Campbell, K. F., M. Inst. C.E.	Borough Engineer, Huddersfield.
1888 May 12	Capon, E. R.	Surveyor to the Urban District Council, Epsom.
1890 Oct. 18 a1899 Jan. 21	Card, H...	North Street, Lewes.
1903 Feb. 21	Carter, A. H.	Surveyor to the Urban District Council, Litherland, Liverpool.

Date of Election and Transfer.		
1901 June 27	CARTER, G. E.	Surveyor to the Rural District Council, Winchester.
1897 June 19	CARTER, G. F.	Surveyor to the Urban District Council, Mexborough.
G1892 July 11 TA1901 Dec. 7 T1904 Jan. 23	*CARTER, G. F., M.Inst.C.E...	Borough Engineer, Croydon.
1898 Dec. 17	CARTWRIGHT, A. S.	Surveyor to the Urban District Council, Wilmslow, Cheshire.
1873 May 2	CARTWRIGHT, J., M. Inst. C.E. (*Past President.*)	21 Parsons Lane, Bury.
1904 June 26	CARVER, W.	Surveyor to the Rural District Council, Melford. 3 Melford Road, Sudbury, Suffolk.
1895 Mar. 16	CASS, R. W.	Surveyor to the Urban District Council, Farnham, Surrey.
1895 Mar. 16 R1899 Feb. 25	CATT, A. J.	"Laurel Dene," Kingston-by-Sea, near Brighton.
1896 Mar. 21	CHADWICK, J...	Surveyor to the Urban District Council, Fenny Stratford.
1903 Jan. 17	CHAMBERS, S. H. (*Member of Council.*)	Surveyor to the Urban District Council, Hampton. *Hon. Secretary*, Home District.
1901 Dec. 7	CHANCELLOR, W. B.	City Surveyor, Lichfield.
1897 Jan. 16	CHAPMAN, C. R. W.	Surveyor to the Urban District Council, Wembley.
1893 Mar. 4 R1899 May 6	CHARLES, T.	Bessborough Road, Harrow.
1884 Dec. 20	CHART, R. M.	Surveyor to the Rural District Council, Croydon. Town Hall, Croydon.
1900 Feb. 10	CHOWINS, W. H.	Surveyor to the Urban District Council, Burnham, Somerset.
1906 Mar. 3	CHRISTIE, S. L.	Burgh Surveyor, Montrose, N.B.
1884 Oct. 9 R1907 June 20	CLARE, J., A.M. Inst. C.E...	Surveyor, Sleaford.
1898 Sept. 3	CLARK, E. O'N.	County Surveyor, Leitrim.
A1902 May 10 T1904 Apr. 30	CLARKE, G. E.	Borough Surveyor, Boston, Lincolnshire.
1899 Oct. 21	CLARKE, H. A.	Surveyor to the Urban District Council, Briton Ferry.
1898 Oct. 15	CLARRY, W. H., A. M. Inst. C.E.	Borough Surveyor, Sutton Coldfield.
1886 Dec. 18	CLARSON, H. J.	Surveyor to the Rural District Council, Tamworth.
1901 May 11	CLAYTON, F. T.	Borough Engineer, Reigate.
1893 July 31	CLOUGH, W.	Surveyor to the Urban District Council, Audenshaw.
1899 Oct. 21	CLUCAS, R. H.	Borough Surveyor, Kingston-on-Thames.
G1894 July 7 T1896 Oct. 24	*COALES, H. F.	Surveyor to the Urban District Council, Sunbury-on-Thames.
G1886 Oct. 16 T1888 July 12	*COALES, H. G., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, Market Harborough.
1882 Sept. 30	COCKRILL, J. W., M. Inst. C.E. (*Member of Council.*)	Borough Surveyor, Great Yarmouth. *Hon. Secretary*, Eastern District.

Date of Election and Transfer.		
1893 June 24	Cockrill, T., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, Biggleswade, Beds.
1904 June 26	Coleby, H. J.	Surveyor to the Rural District Council, Atherstone, Warwickshire.
1892 Sept. 24	Collen, W. M.A., M.Inst.C.E.	County Surveyor, Dublin.
1897 July 31	Collingwood, T. A.	Surveyor to the Urban District Council, Itchen, Woolston, Southampton.
1888 May 12	COLLINS, A. E., M.Inst.C.E. (*Past President.*) (*Member of Council.*)	City Engineer, Norwich.
1900 Oct. 15 R1901 June 27	Collins, G. M.	17 Saville Road, Blackpool.
1896 Jan. 18	Collins, R.	Surveyor to the Urban District Council, Enfield, N.
1905 Apr. 29	Collins, W. A.	Surveyor to the Rural District Council, Bridgwater.
1886 May 1 R1897 Feb. 13	Comber, P. F., M. Inst. C.E.	19 Lower Leeson Street, Dublin.
G1897 July 31 T1900 Dec. 15	*Cook, F. C.	Surveyor to the Urban District Council, Nuneaton.
1893 Apr. 22	Cook, F. P., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, Mansfield Woodhouse.
G1888 July 12 T1890 Mar. 29	*Cook, J., Assoc. M. Inst. C.E.	11 Dalton Road, Liscard, Cheshire.
G1888 July 12 T1890 Mar. 29	*Cooper, C. H., M. Inst. C.E. (*Member of Council.*)	Borough Engineer, Wimbledon. 15 Dora Road, Wimbledon Park, S.W.
1898 Sept. 3	Cooper, E. C.	Surveyor to the Urban District Council, Shanklin, Isle of Wight.
1894 Oct. 20	Cooper, F. A., C.M.G., M. Inst. C.E.	Director of Public Works, Colombo, Ceylon.
1887 Sept. 17	Cooper, W. W.	Surveyor to the Urban District Council, Slough.
1893 Apr. 22 R1902 Nov. 8	Copley, C. T., A.M.Inst.C.E.	252 Barkerhouse Road, Nelson, Lancashire.
1896 Nov. 28	Corbett, J.	Borough Engineer, Salford.
1896 Jan. 18	Cordon, R. C.	Surveyor to the Rural District Council, Belper. "Belmont," Duffield, near Derby.
G1896 May 29 T1897 June 19	*Corrie, H. W.	Surveyor to the Urban District Council, Lower Bebington, Cheshire.
1894 June 21 R1903 Jan. 17	Cotterell, A. P. I., M.Inst. C.E.	28 Baldwin Street, Bristol; and 17 Victoria Street, S.W.
1906 Mar. 3	Cottle, F.	Borough Engineer, Douglas, Isle of Man.
1891 June 25 R1897 July 31	Coverley, J. S.	Surveyor, Penmaenmawr.
1898 May 21	Cox, J.	Surveyor to the Urban District Council, Margam, Port Talbot.
P1880 Feb. 7	Cox, J. H., M. Inst. C.E. ..	City Surveyor, Bradford.
1900 Mar. 10	Crabtree, W. R., M.Sc.(Vict.), A. M. Inst. C.E.	Highway Surveyor to the Rural District Council, Doncaster.

Date of Election and Transfer.		
P1881 May 6	CREER, A., Assoc. M. Inst.C.E.	City Surveyor, York.
1900 July 19	CROSS, A. W., A. M. Inst. C.E.	Surveyor to the Urban District Council, King's Norton.
1889 Dec. 14	*CROWTHER, J. A., Assoc. M. Inst. C.E.	Borough Engineer, Southampton.
G1900 Jan. 19 T1903 May 16	*CRUMP, E. H., A. M. Inst. C.E.	Surveyor to the Urban District Council, Hinckley.
G1898 June 30 T1904 Apr. 30	*CUDBIRD, T. O.	Borough Surveyor, Beccles.
1900 June 16	CUMMING, W.	Highway Surveyor to the Rural District Council, Lanchester, co. Durham.
1889 Dec. 14	CURRALL, A. E.	Surveyor to the Rural District Council, Solihull, Warwickshire.
1896 Apr. 25	CURRY, W. F.	P.W.D., Pretoria, South Africa.
1893 Mar. 4 R1899 Feb. 25	CURRY, W. T., A. M. Inst.C.E.	Minas de Rio Tinto, Provincio Huetra, Spain.
1897 Feb. 13	CUTLER, H. A., M. Inst. C.E. (*Member of Council.*)	City Surveyor, Belfast.
1893 June 24	*DALTON, J. P. .. .. .. (*Member of Council.*)	Surveyor to the Urban District Council, Ryton-on-Tyne. *Hon. Secretary*, Northern District.
1899 Jan. 21	DAVIDSON, J. F.	Surveyor to the Urban District Council, Willington Quay.
1900 Oct. 15	DAVIES, W. J.	Surveyor to the Urban Dristrict Council, Nantyglo and Blaina. Council Offices, Blaina.
1880 Apr. 10	DAVIS, A. T., M. Inst. C.E. (*Past President.*) (*Member of Council.*)	County Surveyor, Salop. Shrewsbury.
1900 Oct. 15	*DAWSON, C. F.	Surveyor to the Urban District Council, Barking.
1884 Apr. 19 R1902 Nov. 8	DAWSON, C. J.	Wykeham House, Barking.
1896 July 25	DAWSON, N. H.	Borough Surveyor, Banbury.
1879 May 1	DAWSON, W., M. Inst. C.E.	Surveyor to the Urban District Council, Leyton, N.E.
1898 Jan. 15	DAY, C.	Borough Surveyor, Chatham.
1873 Dec. 9	DEACON, G. F., LL.D. (Glasgow), M. Inst. C.E. (*Past President.*)	16 Great George Street, Westminster, S.W.
1898 Jan. 15	DEANE, J. W...	Surveyor to the Urban District Council, Smallthorne.
1892 Mar. 11	*DEARDEN, H., A. M. Inst. C.E.	Borough Engineer, Dewsbury.
1904 July 14	DELANY, J. F.	City Engineer, Cork.
P1890 Feb. 1	DENNIS, N. F., A.M.Inst.C.E.	Borough Engineer, West Hartlepool.
1896 July 25	DEWHIRST, J...	Surveyor to the Rural District Council, Chelmsford.
G1898 Oct. 15 T1899 June 10	*DICKINSON, A. J.	Surveyor to the Urban District Council, Redditch.
1895 June 27	DICKINSON, R.	Surveyor to the Urban District Council, Berwick-on-Tweed.
1890 Sept. 13 R1896 Jan. 18	DICKINSON, T. B., Assoc. M. Inst. C.E.	Cliffe Terrace, Ranmore, Sheffield.

Date of Election and Transfer.		
1900 Feb. 10	DIGGLE, JAMES	Surveyor to the Urban District Council, Matlock.
1881 Dec. 10	DIGGLE, J., A.M. Inst. C.E.	Water Engineer, Heywood.
1889 Sept. 21	DIGGLE, WM.	Surveyor to the Rural District Council, Runcorn. Frodsham, Chester.
1877 Oct. 20	DITCHAM, H.	Borough Surveyor, Harwich.
1897 Apr. 10	DIVER, D. J.	Surveyor to the Urban District Council, Marple, near Stockport.
1897 Jan. 16 R1903 Jan. 17	DIXON, F. J., A.M. Inst. C.E.	Waterworks Engineer, Harrogate.
E1891 Aug. 1 T1896 Oct. 24	*DIXON, J. R., M. Inst. C.E.	Borough Engineer, Town Hall, Woolwich.
1887 June 18	DIXON, R., Assoc.M.Inst.C.E.	Borough Surveyor, Stratford-on-Avon.
1889 July 4	DODD, P., Assoc. M. Inst.C.E.	Borough Surveyor, Western District, Wandsworth, S.W.
1897 Jan. 16	*DODGEON, A.	Surveyor to the Urban District Council, Clayton-le-Moors.
1888 May 12	DORMAN, B. H., M. Inst. C.E. (*Member of Council.*)	County Surveyor, Armagh. *Hon. Secretary*, Irish District.
1898 June 30	DORMER, P. C.	Surveyor to the Urban District Council, Chesham, Bucks.
E1903 June 25 T1904 Sept. 17	*DOUGLAS, S.	Surveyor to the Urban District Council, Kenilworth.
1906 Jan. 20	DOUGLASS, W. L., Assoc. M. Inst. C.E.	District Engineer, Middle Ward, Lanark County. District Offices, Hamilton, N.B.
1899 Oct. 21	DRYLAND, A., A. M. Inst. C.E.	County Surveyor, Wiltshire.
1891 Dec. 12	DUFFIN, W. E. L., M. Inst. C.E. I.	County Surveyor, Waterford, Ireland.
1900 Dec. 15 R1901 June 8	DUNCH, T. H.	27 Clement's Lane, Lombard Street, E.C.
1898 May 21	DUNN, J...	Surveyor to the Rural District Council, Chesterton. Brunswick House, Cambridge.
1873 Feb. 15	DUNSCOMBE, C., M.A., M. Inst. C.E.	92 Victoria Street, Westminster, S.W.
E1891 Jan. 21 T1892 Sept. 24	*DYACK, W., M. Inst. C.E. ..	Burgh Surveyor, Aberdeen.
1882 June 29	DYER, S...	Engineer to the Rural District Council, Bridlington, 29 Quay Road, Bridlington.
1879 May 1	EARNSHAW, J. T., Assoc. M. Inst. C.E.	Borough Surveyor, Ashton-under-Lyne, Lancashire.
1904 Aug. 3	EASTON, W. C., B. Sc., M. Inst. C.E.	Glasgow Main Drainage Works, Partick, N.B.
1900 May 19 R1901 Dec. 7	*EASTWOOD, J., A.M. Inst. C.E.	2 Dunkirk Crescent, Halifax.
1883 Aug. 4	EATON-SHORE, G., Assoc. M. Inst. C.E.	Borough Surveyor, Crewe.
1877 Nov. 18	EAYRS, J. T., M. Inst. C.E. (*Past President.*)	39 Corporation Street, Birmingham.
1890 May 3	EBBETTS, D. J.	Surveyor to the Urban District Council, Acton.
1890 Feb. 1	EDDOWES, W. C.	Borough Surveyor, Shrewsbury.

Date of Election and Transfer.		
1891 Jan. 21 R1896 Jan. 18	*Edge, F. J., M. Inst. C.E. ..	22 Collingwood Buildings, Newcastle-on-Tyne.
1891 Sept. 12	Edmondson, S.	Surveyor to the Rural District Council, Burnley.
1904 Jan. 23	Edwards, H. C. J., Assoc. M. Inst. C.E.	Borough Engineer, Lambeth.
1907 Nov. 2	Elce, W. H., A. M. Inst. C.E.	Borough Engineer, Bacup.
1897 July 31	*Elford, E. J.	Borough Surveyor, Southend-on-Sea.
1885 Oct. 8	Elford, J.	Consulting Engineer, Poole.
1873 Feb. 15	ELLICE-CLARK, E. B., M. Inst. C.E. (*Past President.*)	13 Charles Street, St. James's, London, S.W.
1900 Apr. 21	Elliott, F. T.	"Woodbine," Albion Road, Birchington-on-Sea.
1907 May 25	England, J.	Borough Engineer, Wrexham.
1895 July 27	Entwisle, H.	Surveyor to the Urban District Council, Swinton, near Manchester.
1897 Jan. 16	Evans, E., A. M. Inst. C.E.	County Surveyor, Carnarvonshire.
1895 Jan. 19	Evans, E. L., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, Penarth, S. Wales.
1896 May 29	Evans, J. P.	Surveyor to the Rural District Council, Wrexham.
1903 Oct. 17	Evans, S.	County Surveyor, Mold, Flintshire.
1890 June 7	Fairley, W., A.M. Inst. C.E.	Richmond Main Sewerage Board, Kew Gardens, S.W., and 69 Victoria Street, S.W.
G1898 June 30 T1899 Feb. 25	*Farnham, W. A.	Surveyor to the Urban District Council, Foots Cray. Sidcup.
1887 July 14	Farrall, T.	Surveyor to Urban District Council, Sherborne, Dorset.
1893 July 31	Farrington, T. B., A. M. Inst. C.E.	Surveyor to the Rural District Council, Conway. Trinity Square, Llandudno.
1896 Jan. 18	Farrington, W., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, Woodford Green, Essex.
1896 Nov. 28	Feather, F.	Surveyor, Cheriton, near Folkestone.
1900 Dec. 15	*Fellows, T. E.	Surveyor to the Urban District Council, Willenhall.
1894 Jan. 13	Fenn, T...	Surveyor to the Urban District Council, Belper.
1887 Sept. 17 R1899 June 10	Fiddian, W.	Engineer to Stourbridge and Stour Valley Sewerage Boards. Old Bank Offices, Stourbridge.
P1899 Jan. 21	Fidler, A., M. Inst. C.E. .. (*Member of Council.*)	Borough Engineer, Northampton.
G1891 June 25 T1906 Sept. 22	*Finch, A. R., A. M. Inst. C.E.	Borough Surveyor, Kensington.
G1898 June 30 T1904 Jan. 23	*Finch, E. E., A. M. Inst. C.E.	Borough Engineer, Bethnal Green.
1904 Nov, 18	Findlay, J. R.	Burgh Surveyor, Leith, N.B.
1894 Jan. 13	Findlay, R., A.M. Inst. C.E.	Surveyor, Eltham Green, S.E.

Date of Election and Transfer.		
G1892 May 28 T1897 Jan. 16 R1903 July 25	*Fitton, G.	Thornfield, Urmston Lane, Stretford, Manchester.
1903 May 16	Fitzmaurice, M., C.M.G., M. Inst. C.E.	Chief Engineer, London County Council, Spring Gardens.
1895 Oct. 19	Fleming, M. J.	Borough Surveyor, Town Hall, Waterford.
1893 Jan. 14 R1899 May 6	Flower, T. J. M., Assoc. M. Inst. C.E.	Scottish Buildings, Baldwin Street, Bristol; and 28 Victoria Street, Westminster, S.W.
1906 Sept. 22	Forbes, A.	County Road Surveyor, Linlithgow, N.B.
G1895 July 27 T1899 Jan. 21	*Forbes, A. H.	Surveyor to the Urban District Council, Saffron Walden.
1896 Nov. 28	Ford, G...	City Surveyor, St. Albans.
1890 Sept. 13 R1905 Jan. 28	Foster, T.	51 State Insurance Buildings, Dale Street, Liverpool.
G1901 June 8 TA1901 Oct. 19 T1907 Sept. 7	*Fowlds, W., A. M. Inst. C.E.	Borough Engineer, Keighley.
1873 May 2	FOWLER, ALFRED M., M. Inst. C.E. (*Past President.*)	1 St. Peter's Square, Manchester.
G1896 Jan. 18 TA1904 May 28 T1906 May 26	*Fox, S. F. L., Assoc. M. Inst. C.E.	Borough Surveyor, Luton.
1897 Mar. 13	Fox-Allin, C. J.	Surveyor to the Urban District Council, Smethwick.
G1898 June 30 T1902 Nov. 8	*Fraser, R. W.	Surveyor to the Urban District Council, Hoylake, Cheshire.
1895 Oct. 19	Frost, H.	Surveyor to the Urban District Council, Gosport and Alverstoke. Gosport.
1887 June 18 R1898 Jan. 15	Fry, W. H., A.M. Inst. C.E.	9 High Street, Gosport.
1877 Oct. 20	Gamble, S. G., Assoc. M. Inst. C.E.	Metropolitan Fire Brigade, Southwark Bridge Road, S.E.
1885 June 6	Gammage, J.	Borough Surveyor, Dudley.
1891 Dec. 12 R1899 June 10	Garratt, C. T.	Estate Office, Newtown Linford, Leicestershire.
1894 Mar. 3	Garrett, J. H.	County Surveyor, Worcester.
1886 Mar. 18 R1902 Feb. 22	Gaskell, P.	Albert Chambers, Carr Lane, Hull.
1902 Jan. 25	Gent, T. W. B.	Surveyor to the Rural District Council, Leigh.
1902 Feb. 22	George-Powell, J.	Surveyor to the Rural District Council, Godstone, Surrey.
1905 Jan. 28	Gettings, C. F.	Surveyor to the Urban District Council, Teignmouth.
1901 Oct. 19	Gibbs, A. G.	Surveyor to the Rural District Council, Midhurst, Sussex.
1900 Mar. 10	Gibson, S.	Surveyor to the Urban District Council, Biddulph.
1889 Dec. 14	Ginn, A. F.	District Surveyor to the Kent County Council, Tonbridge. 70 Quarry Hill, Tonbridge.

Date of Election and Transfer.		
1899 June 10	GLADWELL, A.	Engineer and Surveyor, Rural District Council, Eton. 160 High Street, Slough, Bucks.
1904 Jan. 23	GLEDHILL, G.	Surveyor to the Urban District Council, Balby with Hexthorpe.
1893 May 13	*GLOYNE, R.M., M. Inst. C.E.	District Engineer, Spring Gardens, S.W.
1895 Jan. 19	GOLDER, T. C.	Borough Surveyor, Deal.
1904 Feb. 27	GOLDSWORTHY-CRUMP, T. ..	Surveyor to the Rural District Council, Taunton. 8 St. George's Terrace, Wilton, Taunton.
1886 June 12	GOODYEAR, H., Assoc. M.Inst. C.E.	Borough Surveyor, Colchester.
1897 June 19	GORDON, F.	Surveyor to the Rural District Council, Halifax. Clifton, Brighouse.
1899 June 10	GOUDIE, A. H.	Burgh Engineer, Stirling, N.B.
G1897 June 19 T1901 Dec. 7	*GRANT, F. T...	Borough Surveyor, Gravesend.
1905 Sept. 23	GRAY, C. C.	Surveyor to the Urban District Council, Hayes.
G1887 Feb. 5 PPT1898 Apr. 22	*GREATOREX, A.D., M. Inst. C.E. (*Member of Council.*)	Borough Surveyor, West Bromwich.
1895 Mar. 5	GREEN, A. A.	Borough Surveyor, Brackley.
1899 June 10	GREEN, G., A.M. Inst. C.E...	Borough Engineer, Wolverhampton.
1901 Feb. 16	GREEN, J. S.	Borough Engineer, Haslingden.
1897 Mar. 13	GREEN, W.	Surveyor to the Urban District Council, Castleford.
A1901 Dec. 7 T1903 Dec. 12	GREENSHIELDS, N., Assoc. M. Inst. C.E.	Borough Engineer, Bedford.
1890 May 3 R1898 Apr. 23	GREENWELL, A., Assoc. M. Inst. C.E.	30 Furnival Street, Holborn, E.C.
1898 Mar. 19	GREGORY, T.	Surveyor to the Urban District Council, Newburn-on-Tyne.
1892 Jan. 16	GREGSON, G.	Surveyor to the Rural District Council, Durham.
1886 Oct. 16	GREGSON, J., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, Padiham, near Burnley.
1882 Sept. 30	GRIEVES, R.	Surveyor to the Urban District Council, Blyth, Northumberland.
1897 June 19	GRIEVES, W. H.	Surveyor to the Urban District Council, Buxton.
1904 Oct. 29	*GRIFFITHS, H. Ll., ...	Borough Surveyor, Brecon.
1886 Sept. 11	GRIMLEY, S. S., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, Hendon.
1899 Dec. 16	GRIMSHAW, F. H., A.M. Inst. C.E.	Surveyor to the Urban District Council, Atherton.
1898 Dec. 17	GUILBERT, T. J.	States Surveyor, Guernsey.
1892 Apr. 28	GUNNIS, J. W.	County Surveyor, Longford, Ireland.
1890 Mar. 29	GUNYON, C. J., A.M. Inst.C.E.	Surveyor to the Urban District Council, Wood Green, N.

Date of Election and Transfer.		
1891 Dec. 12	Hackett, E. A., M.E., M. Inst. C.E.	County Surveyor, Clonmel, Tipperary, Ireland.
1897 June 19	Hague, S.	Borough Surveyor, Dukinfield.
1885 June 6	Haigh, J., A.M. Inst. C.E. ..	Borough Surveyor, Abergavenny.
1906 June 28	*Hailstone, T. H.	Borough Surveyor, Richmond, Yorks.
1896 Apr. 25	Hainsworth, M.	Surveyor to the Urban District Council, Teddington.
1902 Sept. 6	Hale, A.	Municipal Engineer, Howrah, Bengal.
G1899 Dec. 16 T1901 Oct. 19	*Hall, C...	Surveyor to the Urban District Council, Droylsden, near Manchester.
1902 Nov. 8	Hall, E.	Borough Surveyor, Carnarvon.
1884 Apr. 19 R1903 Mar. 21	Hall, J., M. Inst. C.E. (*Member of Council.*)	Executive Engineer, Municipal Offices, Bombay. *Hon. Secretary*, Indian District.
1886 May 1	Hall, W., A.M. Inst. C.E.	Surveyor to the Urban District Council, Great Crosby.
1900 June 16	Hallam, R.	Surveyor to the Rural District Council, Eton.
1901 May 11	Haller, J. C.	Surveyor to the Urban District Council, Carlton, near Nottingham.
1905 June 22	*Halstead, B.	Surveyor to the Urban District Council, Brierfield, Lancs.
1894 July 7	Hamar, A.	Borough Surveyor, Bishop's Castle, Shropshire.
1887 Mar. 12	Hamby, G. H., Assoc.M.Inst. C.E.	Borough Engineer, Lowestoft.
1897 Feb. 13	Hamp, H. J., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, New Swindon.
1897 Mar. 13	Hanson, J. H.	Surveyor to the Urban District Council, Cottingham, Yorks.
1890 Sept. 13	Hanson, W.	Surveyor to the Urban District Council, Wantage.
1896 Jan. 18	Hara, R.	City Engineer, Yokohama, Japan.
1873 Feb. 15	Harding, J. R.	Ashley Road, Epsom, Surrey.
G1896 Nov. 28 T1899 June 10	*Harding, W. D.	Borough Engineer, Bury St. Edmunds.
1899 June 29	*Hargreaves, J. E.	Surveyor to the Urban District Council, Farnborough, Hants.
1899 May 6	Harman, E. A., M. Inst. C.E.	Corporation Gas Engineer, Huddersfield.
1897 Mar. 13	Harpur, A. O.	Surveyor to the Urban District Council, Caerphilly.
1905 Jan. 28	Harpur, J. L.	Town Surveyor, Brierley Hill.
1894 Mar. 3	HARPUR, W., M. Inst. C.E. (*Past President. Member of Council.*)	City Engineer, Cardiff.
1896 Jan. 18	Harris, F.	Surveyor to the Rural District Council, Tonbridge. Bidborough, Tunbridge Wells.
G1901 June 8 T1907 Jan. 19	Harris, K. J. S.	Borough Surveyor, Wisbech.

Date of Election and Transfer.		
1901 May 11	HARRISON, A., M.Inst.C.E. ..	Borough Engineer, Southwark. Town Hall, Walworth Road, S.E.
1906 Apr. 28	*HARRISON, E. Y., Assoc. M. Inst. C.E.	Surveyor and Water Engineer to the Urban District Council, Wellingborough.
1899 June 29	HARRISON, G. F. P.	Surveyor to the Rural District Council, East Stow. Stowmarket, Suffolk.
G1900 Mar. 19 T1905 Mar. 3	*HARRISON, J. W.	Surveyor to the Urban District Council, Wombwell, Yorks.
1896 Nov. 28 R1904 Jan. 23	HARSTON, W., A.M. Inst. C.E.	8 Hythe Street, Dartford.
1905 Sept. 23	HART, G. A.	Sewerage Engineer, Municipal Buildings, Leeds.
1896 Oct. 24	HARTLEY, T. H.	Borough Surveyor, Colne.
P1887 June 18	HARTY, S., M. Inst. C.E. I. ..	City Engineer, Dublin.
1893 Oct. 21	HARVEY, T. F., Assoc. M. Inst. C.E.	Borough Engineer, Merthyr Tydvil.
1907 Apr. 27	HAWKE, W. C., A.M. Inst. C.E.	Borough Surveyor, Dover.
1889 Feb. 9	HAWKINS, I. T., Assoc. M. Inst. C.E.	Director of Public Works, Lagos.
1906 Dec. 15	HAWKINS, J. F.	County Surv., Roads & Bridges, Berkshire. Reading.
1892 Apr. 23	HAWLEY, G. W.	Highway Surveyor R.D.C., Basford. Burton Buildings, Parliament St., Nottingham.
1902 July 10	HAYNES, H. T., Assoc. M.Inst. C.E.	City Engineer, Perth, West Australia.
1895 Apr. 20	HAYNES, R. H., M. Inst. C.E.	Borough Engineer, Newport, Mon.
G1897 June 19 T1898 Jan. 15	*HAYWARD, T. W. A., A.M. Inst. C.E. (*Member of Council.*)	Borough Surveyor, Town Hall, Battersea.
G1899 Jan. 12 T1903 June 25	*HAYWOOD, S. S.	Borough Engineer, Brighouse.
1907 Mar. 2	HEAP, J. A.	Borough Surveyor, Todmorden.
1899 June 10	HEATH, J.	Surveyor to the Urban District Council, Urmston.
1885 June 6	HEATON, G., Assoc. M. Inst. C.E.	Surveyor to the Urban Dist. Councils, Abram and Pemberton. King Street, Wigan.
1890 Feb. 1	HENDERSON, A. J., Assoc. M. Inst. C.E.	"Bramley," Killarney Road, Wandsworth, S.W.
G1895 June 27 T1901 Oct. 19	*HENDRY, J. S.	Surveyor to the Urban District Council, Cannock, Staffs.
1897 Feb. 13	HENRY, T.	Surveyor to the Rural District Council, East Retford.
1903 Dec. 12	HENSHAW, R. S.	Surveyor to the Urban District Council, Portland.
1892 June 11	HERON, J., B.E., B.A.	County Surveyor, Co. Down. Courthouse, Downpatrick, Ireland.
1902 May 10	HESLOP, R.	Surveyor to the Urban District Council, Tanfield, co. Durham
1875 Dec. 21	HEWSON, T., M. Inst. C.E. ..	Carlton Chambers, Albion St., Leeds.
1894 July 7	HIGGENS, T. W. E., Assoc. M. Inst. C.E.	Borough Surveyor, Town Hall, Chelsea, S.W.
1898 May 21	HIGGINS, J.	Chief Engineer, Grey Co., New Zealand.

Date of Election and Transfer.		
e1903 Oct. 17 T1906 Nov. 3	*Hill, H. F.	Surveyor to the Urban District Council, Ware.
1898 Dec. 17	Hinchcliffe, D.	Surveyor to the Urban District Council, Shepton Mallet.
1902 July 10	*Hines, C. E.	Surveyor to the Urban District Council, Windermere.
1898 Sept. 3	Hirst, R. P., A.M. Inst. C.E.	Borough Surveyor, Southport.
1895 June 27	Hodgson, W...	Surveyor to the Urban District Council, Keswick.
1896 Apr. 25 R1901 May 11	*Hogbin, L. W.	"Rowena," Preston Road, Leytonstone, N.E.
1890 Feb. 1	Holden, J., A.M. Inst. C.E.	Surveyor to the Rural District Council, Llandaff. Ely, Cardiff.
1897 Jan. 16	Hole, W. P.	Borough Surveyor, Montgomery. Crowther's Hall, Welshpool.
1904 Aug. 16	Holmes, F. G.	Burgh Surveyor, Govan, N.B.
1892 Mar. 11	Holmes, G. W., Assoc. M. Inst. C.E.	Engineer to the Urban District Council, Walthamstow, N.E.
e1903 Dec. 12 T1904 Oct. 29	*Holt, R. B.	Permanent Way Engineer, Wellington Bridge, Leeds.
1901 Dec. 7	*Holt, W.	Surveyor to the Urban District Council, Sale, Cheshire.
1884 Oct. 9	Hooley, Cosmo C., Assoc. M. Inst. C.E.	Surveyor to the Rural District Council, Barton-upon-Irwell. Croft's Bank House, Davyhulme, nr Manchester.
1884 Oct. 9	Hooley, E. P., M.Inst.C.E. (*Vice-President.*)	County Surveyor, Nottingham.
1898 Jan. 15	Hopkinson, F.	Surveyor to the Rural District Council, Blyth and Cuckney. 40 Bridge Street, Worksop.
1891 Dec. 12	Horan, J., M.E., M.Inst.C.E.	County Surveyor, 82 George Street, Limerick, Ireland.
1895 July 27	Horsfall, W. H. D.	Surveyor to the Urban District Council, Southowram. 9 Harrison Road, Halifax.
A1902 Feb. 22 T1906 Nov. 3	Horton, J. W., Assoc.M.Inst. C.E.	County Surveyor, Derbyshire.
1894 Mar. 3	Howard, H.	Surveyor to the Urban District Council, Littlehampton.
P1889 Dec. 14 R1898 Oct. 15	Howard-Smith, W., Assoc. M. Inst. C.E.	"Arosa," Amersham Hill, High Wycombe.
1880 May 27	Howcroft, J...	Surveyor to the Urban District Council, Redcar, Yorkshire.
1894 June 21	Howell, F. G.	County Surveyor, Surrey. Kingston-on-Thames.
1896 Feb. 22	Howse, W. T.	Surveyor to the Urban District Council, Bexley.
1897 June 17	Hughes, H. T.	Highway Surveyor, Hayfield Road, Chapel-en-le-Frith.
1897 Jan. 16	Humphreys, J.	Surveyor to the Urban District Council, Maesteg.
1899 June 1	Humphries, H. H.	Surveyor to the Urban District Council, Erdington.
1894 June 21	Hunt, G. J.	Borough Engineer, Dorchester.
1897 July 8	Hunter, T.	Surveyor to the Urban District Council, Leigh.

Date of Election and Transfer.		
G1891 Aug. 1 T1896 Apr. 25	*HURD, H.	Surveyor to the Urban District Council, Broadstairs.
G1901 Aug. 24 T1901 Dec. 7	*HUTTON, F.	Surveyor to the Urban District Council, Ashton-on-Mersey.
A1902 Feb. 22 T1903 Mar. 21	HUTTON, S.	Surveyor to the Urban District Council, Exmouth.
1898 May 21 R1906 Mar. 3	INGAMELLS, E. W.	Surveyor, Pokesdown.
G1895 Apr. 20 T1896 Oct. 24	*INGHAM, W., A.M. Inst.C.E.	Hydraulic Engineer, Port Elizabeth, South Africa.
1899 Feb. 25	INGRAM, S.	County Surveyor, Devon. Exeter.
1888 Nov. 17	IRVING, W. E.	Surveyor, Toowong, Queensland, Australia.
1893 June 24 R1902 Nov. 8	ISAACS, L. H., A. Inst. C.E.	3 Verulam Buildings, Gray's Inn, W.C.
1904 May 28	IVESON, J. A.	Surveyor to the Rural District Council, 2 Nares Street, Scarborough.
1900 July 19	JACK, G. H.	County Surveyor, Herefordshire.
1893 Oct. 21	JAFFREY, W.	Town Surveyor, Matlock Bath.
1896 Oct. 24	JAMES, A. C., A.M. Inst. C.E.	Surveyor to the Urban District Council, Grays Thurrock. Grays.
1903 Dec. 12	JAMES, C. C., M.Inst.C.E.	The Ministry, P.W.D., Cairo. 28 Victoria Street, S.W.
G1887 Oct. 22 T1890 Mar. 29	*JAMESON, M. W., A. M.Inst. C.E.	Borough Engineer, Stepney. Gt. Alie St., Whitechapel, E.
1897 Feb. 18	JARVIS, R. W.	Surveyor to the Rural District Council, Tenbury.
1885 Apr. 18	JEEVES, E.	Surveyor to the Urban District Council, Melton Mowbray.
G1898 Jan. 15 T1903 Oct. 17	*JEFFES, R. H., A. M. Inst. C.E.	Surveyor to the Urban District Council, Cheshunt.
G1896 Jan. 18 T1896 Oct. 24	*JENKIN, C. J., A.M. Inst.C.E.	Surveyor to the Urban District Council, Finchley, N.
1899 June 10	JENKINS, D. M., A.M.Inst.C.E.	Borough Surveyor, Neath.
1907 Jan 19	JENKINS, J. P.	Borough Surveyor, Penryn, Cornwall.
1880 Feb. 7	JENNINGS, G.	Surveyor, Rotherham.
1895 May 25	JEPSON, J.	Surveyor to the Urban District Council, Levenshulme.
1892 July 21	JEVONS, J. H., A. M. Inst. C.E.	Borough Surveyor, Hertford.
1904 May 28	JOHNSON, J.	Borough Surveyor, Rawtenstall.
1895 June 27	JOHNSTON, J., M. Inst. C.E.	Waterworks Engineer, Brighton.
1883 Aug. 4 R1902 Nov. 8	JONES, W. C., Lt.-Col. A. S., M. Inst. C.E.	Ridge Cottage, Finchampstead, Berks.
1873 Feb. 15	JONES, CHAS., M. Inst. C.E. (*Past President and Gen. Hon. Secretary. Member of Council.*)	Borough Surveyor, Ealing, Middlesex.
1894 July 7	JONES, CHRISTOPHER	Borough Surveyor, Hythe, Kent.
G1903 May 16 T1904 June 26	*JONES, F. W.	Surveyor to the Urban District Council, Frome, Somerset.

Date of Election and Transfer.		
1874 Jan. 29	JONES, I. M., M. Inst. C.E.	City Surveyor, Chester; Engineer to the Dee Bridge Commissioners.
1894 June 21	JONES, J.	Surveyor to the Rural District Council, Hengoed, *viâ* Cardiff.
1894 June 21	JONES, J. O.	Surveyor to the Rural District Council, Biggleswade.
1903 June 6	JONES, R. R.	Surveyor to the Urban District Council, Horsforth.
1900 Mar. 10	JONES, T. C.	Surveyor to the Urban District Council, Frimley. Camberley, Surrey.
1892 May 28	JONES, W., Assoc.M.Inst.C.E. (*Member of Council.*)	Surveyor to the Urban District Council, Colwyn Bay. *Hon. Sec.*, North Wales District.
1897 Feb. 13	JONES, W. J.	Surveyor to the Urban District Council, Rhondda.
1898 Apr. 23	JONES, W. P.	Surveyor to the Urban District Council, Glyncorrwg.
1906 Dec. 15	JOYCE, T. W...	Borough Engineer, Dartmouth.
1891 June 25	JUKES, W. H.	Surveyor to the Urban District Council, Tipton.
1905 Oct. 28	*KAY, G. H.	Surveyor to the Urban District Council, Irlam, Lancs.
1895 July 27 R1899 Dec. 16	KAY, W. B., A.M. Inst. C.E.	Athol Street, Douglas, Isle of Man.
1892 Apr. 23	KENNEDY, J. D.	Borough Surveyor, Retford.
1905 Jan. 28	*KENYON, L.	Surveyor to the Urban District Council, Tottington.
1895 May 25	KEYWOOD, H. G.	Town Hall, Hoyland. Barnsley.
1892 July 11	KIDD, T., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, Swadlincote, Burton-on-Trent.
1899 Oct. 21	KILLICK, J. S.	Highway Surveyor to the Rural District Council, Croydon.
1899 June 29	KILLICK, P. G.	Borough Surveyor, Finsbury, E.C.
1902 May 10 R1903 July 25	KINNISON, A. M.	Abbey Cottage, Leek, Staffs.
1888 Sept. 15	KIRK, T., Assoc. M. Inst. C.E.	TownEngineer,Ipswich,Queensland.
1907 May 25	KIRKPATRICK, C. R. S., A.M. Inst. C.E.	City Engineer, Newcastle-on-Tyne.
1895 Oct. 19	KNAPP, R. W.	Borough Surveyor, Andover.
1903 June 25	*KNEWSTUBB, F. W., A.M.Inst. C.E.	Surveyor to the Urban District Council, Haverhill.
1903 June 25	*KNEWSTUBB, J. J.	Surveyor to the Urban District Council, Penrith.
1894 Mar. 3 R1903 Jan. 17	KNIGHT, J. M., A.M.Inst.C.E.	35 Bancroft Road, Mile End. E.
1907 Sept. 7	KUSAKABE, B.	Chief Engineer to Municipality, Tokio, Japan.
1884 Oct. 9	LACEY, F. W., M.Inst.C.E. ..	Borough Engineer, Bournemouth.
G1893 Jan. 14 T1895 Mar. 16	*LACEY, G. W.	Borough Surveyor, Oswestry.

Date of Election and Transfer.		
1882 May 25 B1902 Jan. 25	LAFFAN, G. B., M. Inst. C.E.	Hardy's Chambers, Pietermaritzburg, S.A.
1900 Dec. 15	LAILEY, H. G. N.	Surveyor to the Urban District Council, Trowbridge.
1900 July 19	LAITHWAITE, V.	Surveyor to the Urban District Council, Turton.
1904 Apr. 30	LAMBERT, A. P.	P.W.D., Winchester House, Johannesburg, South Africa.
A1902 Mar. 29 T1905 Oct. 28	LANCASHIRE, W. T., Assoc. M.Inst. C.E.	City Engineer, Leeds.
1904 Oct. 13	LANDALE, G.	Burgh Surveyor, Musselburgh, N.B.
1891 June 6	LANDLESS, J. T., Assoc. M. Inst. C.E.	4 Nicholas Street, Burnley.
1904 Aug. 25	LAWRIE, J. P.	Burgh Surveyor, Bo'ness, N.B.
1884 July 10	LAWSON, C. G., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, Southgate. District Offices, Palmer's Green, N.
1900 Mar. 10	LAWTON, C. H.	Surveyor to the Urban District Council, Warminster. Christchurch Cottage, Warminster, Wilts.
G1899 Oct. 21 T1901 May 11	*LEA, M., A. M. Inst. C.E. ..	City Surveyor, Truro.
1904 Aug. 31	LEE, J.	Burgh Surveyor, Paisley, N.B.
1896 Oct. 24	LEEBODY, J. W.	County Surveyor, Co. Tyrone (S.).
1898 Mar. 19	LEETE, H. J. G.	County Surveyor, Huntingdon.
1880 Apr. 10	LEETE, W. H., A.M.Inst.C.E.	County Surveyor, Bedford.
1900 May 19	LEGG, E. I.	Borough Surveyor, Christchurch, Hants.
1894 May 19	LEIGH, W.	Borough Surveyor, Chorley.
1873 Feb. 15	LEMON, J., M. Inst. C.E. (*Past President.*)	Stockwell Lodge, The Avenue, Southampton.
1899 Oct. 21	LINES, E.	Engineer to the Rural District Council, Chesterfield.
G1896 July 25 T1899 Dec. 16 B1903 Feb. 21	*LIVERSEDGE, J. W.	Surveyor to the Urban District Council, Leigh-on-Sea, Essex.
1891 Mar. 21 B1901 Aug. 24	LIVINGSTONE, G., Assoc. M. Inst. C.E.	216 Church Road, Hove.
1907 May 25	LLOYD-DAVIES, D. E., Assoc. M. Inst. C.E.	Chief Engineer, The Municipality, Alexandria, Egypt.
G1895 May 25 T1900 Oct. 15	*LOBLEY, F. J., A.M.Inst.C.E.	City Surveyor, Chichester.
1873 May 2	LOBLEY, J., M. Inst. C.E. (*Past President.*) (*Member of Council.*)	Borough Engineer, Hanley, Staffordshire.
1896 June 25	LOCKE, W. R.	Borough Surveyor, Town Hall, Hemel Hempstead.
1889 Sept. 21	LOMAX, C. J., Assoc. M. Inst. C.E.	Engineer to the Urban District Council, Gorton. 37 Cross Street, Manchester.
1904 Mar. 26	LONGDIN, H. W.	Surveyor to the Urban District Council, Penge.
1896 Oct. 24	LONGFIELD, R. W. F., M. Inst. C.E.	County Surveyor, Co. Cork (W.). Bandon.
1903 Dec. 12	LONGLEY, H. B.	District Surveyor, Town Hall, Manchester.
1902 Nov. 8	LORD, E. I.	Borough Engineer, Greymouth, New Zealand.

Date of Election and Transfer.		
1901 May 11	LOVEDAY, W. F. .. .. .. (*Member of Council.*)	Borough Surveyor, Stoke Newington, N. *Hon. Sec.* Metropolitan District.
1892 Jan. 16	LOVEGROVE, E. J., M. Inst. C.E.	Borough Engineer, Hornsey, N.
1897 July 8	LUMSDEN, J. L.	Burgh Surveyor, Kirkcaldy.
1896 July 25	LUND, C.	Surveyor to the Urban District Council, Cleckheaton.
1896 Oct. 24	LYNAM, F. J., Assoc. M. Inst. C.E.	County Surveyor, Co. Tyrone (N.).
G1888 July 12 T1897 Oct. 16	*LYNAM, G. T., Assoc. M. Inst. C.E.	Borough Surveyor, Burton-on-Trent.
1891 Aug. 1	LYNAM, P. J.	County Surveyor, Louth. Dundalk, Ireland.
1873 May 2 R1900 Mar. 10	MCBEATH, A. G., Assoc. M. Inst. C.E.	Montagu Road, Sale, Cheshire.
1905 Mar. 3	MCBETH, M. B.	Surveyor to Mid-Argyll District, Argyllshire County Council. County Buildings, Lochgilphead, Argyllshire.
1883 May 30	MACBRAIR, R. A., M.Inst.C.E.	City Engineer, Lincoln.
1904 Aug. 24	MCBRIDE, S.	Burgh Surveyor, Rutherglen, N.B.
1900 Feb. 10	MCDERMID, C.	Surveyor to the Urban District Council, Eston.
1897 Feb. 13	MCDONALD, A. B., M. Inst. C.E.	City Engineer, Glasgow.
1897 Jan. 16	MACKENZIE, D.	County Surveyor, Dunfermline.
1895 Oct. 19	MCKENZIE, J. McD.	Surveyor to the Rural District Council, Bucklow. Mossburn Bldgs., Stamford New Road, Altrincham.
1904 Oct. 1	MACKIE, G. D.	Water Engineer, Municipal Buildings, Clydebank, N.B.
1898 June 30	MCKILLOP, R.	Burgh Surveyor, Perth, N.B.
1906 Mar. 3	*MADEN, J.	Borough Engineer, King Williamstown, S. Africa.
1898 Feb. 19	MADIN, W. B.	Surveyor to the Urban District Council, Rushden.
1886 Dec. 18	MAIR, H., M. Inst. C.E. ..	Borough Engineer, Hammersmith, W.
1900 Feb. 10	MALLINSON, J.	Surveyor to the Urban District Council, Skipton.
G1891 Jan. 21 T1897 June 19 R1904 Jan. 23	*MANLEY, J.	7 Oxford Road, Wokingham.
1892 July 21	MANNING, G. W.	Surveyor to the Rural District Council, Staines.
G1898 Jan. 15 T1901 Aug. 24	*MARKS, C. W...	Borough Surveyor, Wokingham.
1888 July 12	MARKS, H. C., M. Inst. C.E.	City Surveyor, Carlisle.
1899 May 6	MARKS, W. L.	Surveyor to the Urban District Council, Rhymney.
1897 Mar. 13	MARSHALL, J...	Surveyor to the Rural District Council, West Malling.
A1903 Jan. 17 T1907 Nov. 2	MARSHALL, L. P., M. Inst. C.E.	Chief Engineer, Rangoon Municipality.

Date of Election and Transfer.		
1891 Jan. 21 R1902 Nov. 8	MARSTON, C. F., Assoc. M. Inst. C.E.	Masonic Hall Chambers, Mill Street, Sutton Coldfield.
1894 Mar. 3	MARTEN, H. J., Assoc. M. Inst. C.E.	Borough Surveyor, Eastern District, Wandsworth. 215 High Road, Balham, S.W.
1899 May 6	MASON, C. G., Assoc. M. Inst. C.E.	Borough Surveyor, Guildford.
1904 Oct. 22	MASSIE, C.	Water Engineer, Falkirk, N.B.
1890 Mar. 29	MASSIE, F., M. Inst. C.E. ..	Surveyor to the Rural District Council, Wakefield.
1904 Aug. 17	MASSIE, J.	Burgh Engineer, Edinburgh, N.B.
1906 Apr. 28	MATHER, H. T.	Surveyor to the Urban District Council, Surbiton.
1883 Feb. 17	MATHEWS, G. S., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, Dorking.
1898 Dec. 17	*MATTHEWS, E. R., Assoc. M. Inst. C.E.	Borough Surveyor, Bridlington.
1904 May 28	MAUDSLEY, C. W.	Surveyor to the Rural District Council, Oakham, Rutland.
1881 Dec. 10	MAWBEY, E. G., M. Inst. C.E. (*Past President.*)	Borough Engineer, Leicester.
1892 Mar. 11	MAWSON, R. C.	Borough Surveyor, Evesham.
G1896 July 25 T1902 Sept. 6	*MAXWELL, W. H., Assoc. M. Inst. C.E.	Borough Surveyor, Tunbridge Wells.
G1898 Dec. 17 T1904 June 26	*MAY, C. G.	P.W.D., Sepoy Lines, Penang, S.S.
1894 Oct. 20	MAYBURY, H. P.	County Surveyor, Maidstone.
1901 Aug. 24	MAYLAN, S.	Surveyor to the Rural District Council, Basford.
1889 May 18	MAYNE, C., M. Inst. C.E. ..	Engineer and Surveyor to the Municipal Council, Shanghai. *Hon. Corresponding Sec.* for Eastern Asia.
1883 Feb. 17	MEADE, T. DE COURCY, M. Inst. C.E. (*Past President.*)	City Surveyor, Manchester.
1888 July 12	*METCALF, J. W., Assoc. M. Inst. C.E.	Town Surveyor, Newmarket.
1903 June 25	*METCALFE, A. J.	District Surveyor, Ashbourne.
1893 June 24	MILLER, H., M. Inst. C.E. ..	County Surveyor, East Suffolk, Ipswich.
1902 July 10	MILLER, H.	Surveyor to the Urban District Council, Heysham.
1897 Jan. 16	*MILNES, G. P., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, Stroud.
1874 May 23	MITCHELL, J.	Borough Surveyor, Hyde, Manchester.
1896 Oct. 24	MONCUR, J., A.M. Inst. C.E.	County Highway Surveyor, County Buildings, Stafford.
1900 Dec. 15	MONTEATH, G.	County Surveyor, Newtown, St. Boswell's, N.B.
1898 Apr. 23	MORGAN, E. F.	Borough Road Surveyor, Croydon.
1907 May 25	MORGAN, E. L., A. M. Inst. C.E.	Borough Engineer, Bolton.
1895 July 27	MORGAN, G. S.	Surveyor to the Rural District Council, Llantrissant, Glamorgan.

Date of Election and Transfer.		
1892 July 11	MORGAN, J.	Surveyor to the Rural District Council, Pontardawe. Swansea.
1901 June 8	MORGAN, R. P.	Surveyor to the Urban District Council, Towyn.
1874 May 1	MORGAN, W. B., Assoc. M. Inst. C.E.	Borough Surveyor, Weymouth and Melcombe Regis, Dorsetshire.
1905 Oct. 28	MORLEY, E.	Surveyor to the Urban District Council, Walthamstow.
1903 Feb. 21	MOULDING, T., A.M.Inst.C.E. (*Member of Council.*)	City Surveyor, Exeter. *Hon. Secretary*, Western District.
A1902 Jan. 25 T1902 June 7	MOUNT, J. C., A.M. Inst. C.E.	Borough Surveyor, Lancaster.
1885 Feb. 7 R1905 Jan. 28	MOUNTAIN, A. H., Assoc. M. Inst. C.E.	14 Prince's Chambers, 16 John Dalton Street, Manchester.
1898 Sept. 8	MULVANY, C. J., M. Inst. C.E.	County Surveyor, Athlone.
1890 Mar. 29	MURCH, P.	Borough Engineer, Portsmouth.
1896 Nov. 28	MURPHY, P. E., M.Inst. C.E.	Engineer to the Tottenham and Wood Green Joint Drainage Committee. Council Buildings, Tottenham, N.
1904 Aug. 6	MURRAY, J.	County Surveyor, Renfrewshire. Paisley, N.B.
1904 Aug. 17	MURRAY, J.	Burgh Surveyor, Port Glasgow, N.B.
1895 Feb. 16 R1904 Jan. 23	MURZBAN, KHAN BAHADUR M. C., C.I.E., M. Inst. C.E.	"Gulestan," Murzban Road, Bombay.
1896 Oct. 24	NANKIVELL, H. H.	Surveyor to the Urban District Council, Braintree.
G1903 Oct. 17 T1905 May 27	*NASH, F. O. C., Assoc. M.Inst. C.E.	Surveyor to the Urban District Council, Cockermouth.
1905 Oct. 28	NELSON, G., A.M.Inst. C.E.	Surveyor to the Urban District Council, Gosforth.
1897 July 8	NEWMAN, S. J.	Borough Surveyor, Poole.
1906 Sept. 22	NEWTON, A. W.	Surveyor to the Hutt County Council, Wellington, N.Z.
1897 Feb. 13 R1903 Jan. 17	NEWTON, C. E.	19 Cooper Street, Manchester.
G1895 Jan. 19 TA1901 Oct. 19 T1902 Mar. 22	*NEWTON, E. B., A.M. Inst. C.E.	Borough Surveyor, Paddington, W.
1891 Oct. 17	NEWTON, G. H.	Surveyor to the Urban District Council, Denton, Manchester.
1888 May 12	NEWTON, W. J., A.M.Inst.C.E.	Borough Surveyor, Accrington.
G1892 Sept. 24 T1899 Feb. 25	*NICHOLS, A. E., A.M. Inst.C.E.	Borough Engineer, Folkestone.
1904 Aug. 5	NISBET, T., Assoc. M.Inst.C.E.	Master of Works, City Chambers, Glasgow, N.B.
1887 July 14 R1899 Feb. 25	NORRINGTON, J. P., Assoc. M. Inst. C.E.	28 Dulwich Road, Brixton, S.E.
G1897 Mar. 13 T1898 Sept. 3	*NORRIS, J. H.	Borough Surveyor, Godalming.
1886 Dec. 18 R1901 May 11	NORRISH, G. R.	Hawley House, Tudor Road, Upper Norwood.

Date of Election and Transfer.		
1900 Dec. 15	Nuttall, H., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, Kearsley.
1899 Feb. 25	Nuttall, W.	District Surveyor, 28 Crosby Road, Birkdale, Southport.
G1898 June 30 T1899 Oct. 21	*Oakden, R., A.M. Inst. C.E. ..	Surveyor to the Rural District Council, Newark.
A1902 Jan. 25 T1906 Nov. 3	Oakes, H. H.	Town Surveyor, Ventnor, I. of W.
1901 Aug. 24	O'Hara, H.	Surveyor to the Urban District Council, Ballymena, Ireland.
1892 Jan. 16	Oxtoby, W., M. Inst. C.E. ..	Borough Engineer, Camberwell, S.E.
1907 Mar. 2	Palk, D. S.	Engineer-in-charge, P. W. D., Cape Coast, W. Africa.
1896 Apr. 25	Palmer, F. W. J.	Surveyor to the Urban District Council, Herne Bay.
PP1900 Mar. 10	Palmer, P. H., M. Inst. C.E. (*Member of Council.*)	Borough Surveyor, Hastings.
1905 Jan. 28	Pansing, J., A.M. Inst. C.E.I.	Town Surveyor, Wicklow.
1894 Apr. 6	Pardoe, J. C., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, Barry, near Cardiff.
1876 May 1	Parker, J., Assoc. M. Inst. C.E.	City Surveyor, Hereford.
1887 July 14 R1895 June 27	Parker, J., A.M. Inst. C.E.	49 Denmark Villas, Hove, Brighton.
1896 Nov. 28 R1903 Feb. 21	Parker, J. E., A.M. Inst. C.E.	P.O. Chambers, St. Nicholas Square, Newcastle-on-Tyne.
1896 Oct. 24	Parker, S. W.	Surveyor to the Urban District Council, Gainsborough.
1893 July 13	Parr, F., Assoc. M. Inst. C.E.	Borough Surveyor, Bridgwater.
G1898 June 30 T1899 Oct. 21	*Parr, F. H.	Borough Surveyor, Lymington.
G1893 Jan. 14 T1894 Oct. 20	*Parr, N.	Surveyor to the Urban District Council, Brentford.
1905 June 22	*Parry, E.	District Main Road Surveyor, Hertforshire. 66 Whimbush Road, Hitchin, Herts.
P1894 June 21	Paton, J. (*Member of Council.*)	Borough Engineer, Plymouth.
1905 June 22	Pattinson, N. P.	Borough Surveyor, Gateshead.
1895 Jan. 19	Pattison, W. P.	Surveyor to the Urban District Council, Benwell and Fenham.
1897 Jan. 16	Peacock, T. J.	Surveyor to the Rural District Council, Spalding.
1898 Dec. 17	Pearce, F. W.	Surveyor to the Urban District Council, Twickenham.
1899 Oct. 21	Peet, H. F., M. Inst. C.E. (*Member of Council.*)	City Engineer, Bloemfontein, South Africa. *Hon. Sec.* African District.
1891 Dec. 12	Peirce, R., M. Inst. C.E. ..	Municipal Engineer, Singapore, S.S.
A1902 Mar. 22 T1906 Dec. 15	Phillips, G. A., A.M. Inst. C.E.	County Surveyor, Glamorgan.
1889 May 18	Phillips, R., Assoc. M. Inst. C.E.	Late County Surveyor, Gloucester.
1904 May 28	Phipps, F. R., Assoc. M. Inst. C.E.	Borough Surveyor, Basingstoke.

Date of Election and Transfer.		
1901 Aug. 24	Pick, S. P.	County Surveyor, Leicester. 6 Millstone Lane, Leicester.
1901 Oct. 19	Pickard, J. E.	Borough Surveyor, Pontefract, Yorks.
1898 Apr. 23	Picker, E.	Surveyor to the Rural District Council, Beverley.
G1887 June 18 PPT1890 Sept. 13	*Pickering, J. S., M. Inst. C.E. (*Member of Council.*)	Borough Engineer, Cheltenham.
1881 Dec. 10 R1884 May 29	Pickering, R.	11 Lowther Street, Whitehaven.
G1894 Jan. 13 T1895 Oct. 19	*Pickles, G. H., A.M.Inst.C.E.	Borough Engineer, Burnley.
1906 Mar. 3	Picton, T. S...	Borough Engineer, Eccles.
P1881 Dec. 10	Platt, S. S., M. Inst. C.E.	Borough Surveyor, Rochdale.
1893 Oct. 21	Plowright, A. H...	2 Bury Street, Norwich.
1897 July 8	Poole, H. C.	Surveyor to the Urban District Council, Wath-upon-Dearn.
1881 July 7	Porter, R.	Borough Surveyor, Wakefield.
1899 Oct. 21	*Prescott, A. E.	Borough Surveyor, Eastbourne.
1898 Mar. 19	Prescott, W. H., A.M. Inst. C.E. (*Member of Council.*)	Surveyor to the Urban District Council, Tottenham, N.
1892 Jan. 16	Press, W. J.	Surveyor, Burnham, Somerset.
G1894 June 21 T1899 June 29	*Price, A. J.	Surveyor to the Urban District Council, Lytham.
1904 Sept. 29	Pritty, J.	Burgh Engineer, Selkirk, N.B.
1873 May 2	Proctor, J., M. Inst. C.E. ..	Mere Lawn, Bolton, Lancashire.
1892 May 28	Prouse, O. M., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, Ilfracombe.
1904 Aug. 4	Purdie, W. H.	Burgh Engineer, Hamilton, N.B.
1873 May 2	Purnell, E. J.	Water Engineer, Coventry, Warwickshire.
1899 May 6	Purser, W. B., A.M. Inst. C.E.	County Surveyor, Kesteven County Council. Grantham.
G1893 July 31 T1898 June 13	*Putman, W. E., A. M. Inst. C.E.	Borough Surveyor, Morley.
1905 Dec. 9	Putten, E. Van, M.Inst.C.E.	Borough Engineer, Lewisham, Town Hall, Catford, S.E.
1886 Dec. 18 R1901 Oct. 19	Radford, J. C., A. M. Inst. C.E.	163 Upper Richmond Road, Putney, S.W.
1889 July 4	Rapley, W.	Surveyor to the Rural District Council, Dorking.
1898 Apr. 23	Rayner, F. J.	Surveyor to the Urban District Council, Newhaven.
1878 May 1	Read, R., A.M. Inst. C.E. .. (*Member of Council.*)	City Surveyor, Gloucester.
G1897 June 19 TA1901 Dec. 7 T1904 Sept. 17	*Redfern, J. L.	Borough Surveyor, Gillingham, Kent.
1897 Feb. 13	Renwick, R.	Surveyor to the Urban District Council, Horsham.
1892 Mar. 11	Reynolds, E. J., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, Friern Barnet.
1888 July 12 R1902 Feb. 22	Richards, R. W., M. Inst. C.E.	Town Clerk and City Engineer, Dunedin, New Zealand. *Hon. Corresponding Secretary* for Australasia.

Date of Election and Transfer.		
1888 May 12	RICHARDSON, H., Assoc. M. Inst. C.E. (*Member of Council.*)	Surveyor to the Urban Distric Council, Handsworth, Birmingham. *Hon. Secretary* Midland District.
1884 Oct. 9	RICHARDSON, J.	County Surveyor, Rutland. Stamford.
1901 May 11	*RIDLER, W.	Borough Surveyor, Tewkesbury
1892 Mar. 11	RIDOUT, A. R.	Surveyor to the Urban District Council, Stone.
G1901 Aug. 24 TA1905 Dec. 9 T1906 June 28	*RILEY, J.	Sewerage Engineer, Johannesburg, Transvaal, S.A.
G1891 Dec. 12 T1897 Mar. 18	*ROBERTS, F., A. M. Inst.C.E.	Borough Engineer, Worthing.
1891 Oct. 17	ROBINSON, W. P., A.M. Inst. C.E.	Surveyor to the Urban District Council,Skelton-in-Cleveland.
1886 May 1	ROBINSON, W. J.	City Surveyor, Londonderry.
1876 May 1	ROBSON, O. C., M. Inst. C.E. (*Past President. Member of Council.*)	Surveyor to the Urban District Council,Willesden,Middlesex.
1896 Mar. 21	RODWELL, A.	Surveyor to the Rural District Council, Skipton.
1906 Sept. 22	ROGERS, S. G.	Borough Engineer, Chard.
1896 Jan. 18	ROGERS, W. E.	Surveyor to the Urban District Council, Rugely.
1904 Oct. 22	RONALD, D.	Burgh Engineer, Falkirk, N.B.
1895 Jan. 19	ROSS, J. C., A.M. Inst. C.E. ..	Engineer of Water Supply, City Hall, Toowoomba, Queensland, Australia.
G1901 Feb. 16 T1905 Mar. 3	*ROTHERA, A.	Surveyor to the Urban District Council, Thornhill, near Dewsbury.
1880 Oct. 2 R1905 May 27	ROUNTHWAITE, R. S., M. Inst. C.E.	3 Willis Street,Wellington, New Zealand.
1888 May 12	RUCK, F. W.	County Architect, 86 Week Street, Maidstone.
1895 Feb. 16	RUSHBROOKE, T. J.	Borough Surveyor, High Wycombe.
1896 Apr. 25	*RUSHTON, E.	Surveyor to the Urban District Council, Cleethorpes.
A1903 Mar. 21 T1904 Sept. 17	RYMAN, F. R., A.M.Inst.C.E.	Borough Surveyor, Stamford.
1890 Mar. 29 R1904 Mar. 26	*SAISE, A. J., Assoc. M. Inst. C.E.	Eagle Insurance Buildings, Baldwin Street, Bristol.
1899 Feb. 25	SALKIELD, T.	Chief Engineer to Municipality of Delhi, India.
A1903 June 25 T1906 Dec. 15	*SAUNDERS, E. Y.	Borough Surveyor, Barnstaple.
G1887 June 18 T1898 May 21 R1903 Mar. 21	*SAUNDERS, J., A.M. Inst. C.E.	Imperial Chambers, Newark.
1894 Mar. 3	SAVILLE, J.	Town Surveyor, Heckmondwike.
1899 May 6	SCHOFIELD, W. H., A.M. Inst. C.E.	County Surveyor, Lancashire. County Hall, Preston.
1894 June 21	SCORGIE, N., M. Inst. C.E. ..	Boro' Surveyor, Hackney, N.E.
1892 Sept. 24	SCOTT, A. F.	Surveyor to the Urban District Council, Cromer.
1888 Nov. 17	SCOTT, H. H., A.M.Inst.C.E.	Engineer to the Commissioners, Hove.

Date of Election and Transfer.		
1901 Aug. 24	Scott, J. H.	Surveyor to the Urban District Council, Winton, Bournemouth.
1880 May 27	Scott, R. S., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, Bishop's Stortford.
1897 Feb. 18	Scott, T.	Surveyor to the Rural District Council, Tadcaster, Aberford, near Leeds.
1904 Aug. 4	Scott, T. H	Burgh Surveyor, Inverness, N.B.
1897 July 8	Senior, C. E...	Surveyor to the Urban District Council, Neston, Cheshire.
1896 Oct. 24	Senior, J. S.	Surveyor to the Urban District Council, Swanage.
G1894 July 7 T1898 Mar. 19	*Settle, J. A., A.M.Inst.C.E.	Borough Engineer and Surveyor, Heywood, Manchester.
A1902 Nov. 8 T1907 Mar. 2	*Shackleton, W., A. M. Inst. C.E.	Borough Surveyor, Grantham.
1873 May 2 R1903 May 16	Sharman, E.	Croyland Abbey, Wellingborough, Northamptonshire.
1896 Nov. 28	Sharpe, J. E.	Surveyor to the Urban District Council, Otley, Yorks.
1891 June 6	Shaw, H., Assoc.M.Inst.C.E.	Surveyor to the Urban District Council, Ilford.
1890 June 7 R1901 Aug. 24	Shaw, J. H.	Surveyor to the Urban District Council, Brownhills, Staffs.
1892 May 28	Sheard, W. C., Assoc.M. Inst. C.E.	"Stonelea," Newtown, New Mills, near Stockport.
1905 June 22	Shell, W. S.	Surveyor to the Urban District Council, Consett, Durham.
1891 Oct. 17	Shepherd, G. J.	Surveyor to the Rural District Council, Kidderminster.
1884 June 10	Sheppard, G.	Borough Surveyor, Newark.
A1905 May 27 T1907 May 25	Sherren, A. O., A.M.Inst.C.E.	Surveyor to the Urban District Council, Cheriton.
1892 July 11	Shillington, H., M.E. ..	Town Surveyor, Lurgan, Ireland.
1895 Oct. 19	Shipton, T. H.	Surveyor to the Urban District Council, Oldbury.
1902 June 7	Siddalls, J.	Borough Surveyor, Tiverton.
1887 Oct. 22	Siddons, J. M.	Surveyor to the River Nene Commissioners, Oundle.
1896 Jan. 18	Sidwell, H. T.	Surveyor to the Rural District Council, Rochford, Essex.
P1887 July 14 R1898 Oct. 15	*Silcock, E. J., M. Inst. C.E.	10 Park Row, Leeds.
1897 Mar. 13	Silcock, H.	Surveyor to the Rural District Council, Blackwell. 67 Westgate, Mansfield.
1903 Oct. 17	Simmonds, T. B.	Surveyor to the Urban District Council, New Malden.
1904 May 28	*Simmons, R.	Surveyor to the Urban District Council, Little Woolton, near Liverpool.
1901 Feb. 16	Simpson, H. Farr	County Surveyor, Northern Division, Isle of Ely. Wisbech.
1891 Aug. 1 R1895 June 27	Simpson, W. H., A. M. Inst. C.E.	Horsefair Street, Leicester.

Date of Election and Transfer.		
1906 Dec. 15	SIMS, A.	Surveyor to the Rural District Council, Ashford.
1890 Sept. 13	SINCLAIR, J. S., A.M. Inst. C.E.	Borough Surveyor, Widnes.
1895 Oct. 19	SKELTON, R., A.M. Inst. C.E.	Municipal Engineer, Colombo, Ceylon.
1898 Oct. 15	SMAIL, J. M., M. Inst. C.E. ..	Chief Engineer to the Metropolitan Board of Works, Sydney, N.S.W.
1898 June 30	SMALES, J. E...	Surveyor to the Urban District Council, Leatherhead.
1895 June 27	SMILLIE, J. F.	Borough Surveyor, Tynemouth.
1892 Mar. 11	SMITH, C. CHAMBERS	Surveyor to the Urban District Council, Sutton, Surrey.
1902 Sept. 6	SMITH, F. H.	Surveyor to the Urban District Council, Portishead.
G1904 May 28 T1904 Sept. 17	*SMITH, F. HALL	Surveyor to the Urban District Council, Sheringham.
1899 Mar. 25	SMITH, H. W., A.M. Inst. C.E. (*Member of Council.*)	Borough Engineer, Scarborough. *Hon. Secretary*, Yorkshire District.
1897 May 15	SMITH, JAMES	Borough Surveyor, Buckingham.
1895 May 25	SMITH, J. B.	Surveyor to the Urban District Council, Tyldesley.
1901 Dec. 7	SMITH, J. GOULD, A.M. Inst. C.E.	Borough Surveyor, Beverley.
1905 Jan. 28	*SMITH, J. H. WOOLSTON, A. M. Inst. C.E.	Surveyor to the Urban District Council, Minehead.
G1898 Dec. 17 TA1901 Oct. 19 T1903 Oct. 17	*SMITH, J. WALKER	Borough Surveyor, Barrow-in-Furness.
1904 Aug. 6	SMITH, P. C.	Burgh Surveyor, Arbroath, N.B.
P1891 Dec. 12	SMITH, T. R., A.M. Inst. C.E.	Surveyor to the Urban District Council, Kettering.
1897 Jan. 16	SMITH, V.	Borough Surveyor, Chesterfield.
G1888 Jan. 14 T1897 Mar. 13	*SMITH-SAVILLE, R. W., Assoc. M. Inst. C.E.	Borough Surveyor, Darwen.
1898 Jan. 15 R1907 Jan. 19	SNELL, J. F. C., M. Inst. C.E.	Caxton House, Westminster, S.W.
1903 Oct. 17	SOWDEN, M.	Surveyor to the Urban District Council, Whitchurch, Salop.
1898 Dec. 17	SPENCER, J.	Surveyor to the Urban District Council, Oakworth. York Chambers, Cooke Street, Keighley.
1873 May 2 R1881 Dec. 10	SPENCER, J. P., A.M. Inst. C.E.	30 Howard Street, North Shields.
1902 May 10	SPENCER, L. G. P., A.M. Inst. C.E.	Borough Engineer, Inglewood, New Zealand.
P1885 June 25 R1888 Sept. 15	SPINKS, W., M. Inst. C.E. ..	39 Prudential Assurance Buildings, Park Row, Leeds.
G1899 Dec. 16 TA1901 Oct. 19 T1904 July 14	*SPRECKLEY, J. A., Assoc. M. Inst. C.E.	Borough Surveyor, Ludlow.
A1904 May 28 T1906 Nov. 3	SPURRELL, E. F.	Borough Surveyor, Holborn.
1880 Feb. 7 R1899 June 10	STAINTHORPE, T. W., A.M. Inst. C.E	P.W.D., Cape Town, South Africa.

Date of Election and Transfer.		
1889 Dec. 14	STALLARD, S., A.M. Inst. C.E.	County Surveyor, Oxfordshire. Oxford.
1892 Mar. 11	STEPHENSON, E. P., Assoc. M. Inst. C.E.	Town Surveyor, Llandudno.
1890 Mar. 29	STEVENS, L.	Surveyor to the Urban District Council, Newton Abbott, Devon.
1892 Mar. 11	STEVENSON, A.	District Surveyor, Ayrshire County Council.
1891 Oct. 17	STEVENSON, J.	Surveyor to the Urban District Council, East Molesey.
1901 Feb. 16	STEWART, J.	Borough Engineer, Dunstable, Beds.
1891 June 25	STICKLAND, E. A., Assoc. M. Inst. C.E.	Borough Surveyor, Windsor.
1897 Jan. 16	STILGOE, H. E., M. Inst. C.E. (*Member of Council.*)	City Engineer, Birmingham.
1900 Dec. 15	STIVEN, E. E.	Borough Surveyor, Whitehaven.
1904 Jan. 23	*STONES, J.	Surveyor to the Rural District Council, Sedgfield, co. Durham.
1898 Mar. 19	STOW, J. F.	Surveyor to the Rural District Council, Uxbridge.
1903 Mar. 11	STREATHER, W. T.	Surveyor to the Urban District Council, Waltham Cross.
1880 May 27	STUBBS, W., A.M. Inst. C.E.	Borough Engineer, Blackburn.
G1892 July 11 T1892 Sept. 24	*SUMNER, F., M. Inst. C.E. ..	City Engineer, Guildhall, London, E.C.
G1907 Jan. 19 T1907 May 25	*SUNDERLAND, C. H.	Surveyor to the Urban District Council, Midsomer Norton.
1895 Mar. 16	*SURTEES, R. T.	Water Engineer to the Urban District Council, Newton-in-Makerfield. Newton-le-Willows, Lancs.
1904 Aug. 10	SUTHERLAND, J. R., A.M.Inst. C.E.	Chief Engineer, Water Department, City Chambers, Glasgow, N.B.
G1899 June 29 T1901 June 27	*SWALES, T. R.	Borough Surveyor, Maldon.
1880 June 23 R1889 Apr. 13	SWARBRICK, J., M. Inst. C.E.	30 St. Anns Street, Manchester.
1899 June 10	SYKES, M. H.	Borough Surveyor, Stockton-on-Tees.
G1902 Feb. 22 TA1904 Dec. 3 T1906 Nov. 3	*TAIT, W. I.	Borough Engineer, Sudbury, Suffolk.
1887 Mar. 12	TANNER, W.	County Surveyor, Monmouthshire. Newport.
1895 Mar. 16	TARBIT, T. H.	Surveyor to the Urban District Council, Loftus, Yorkshire.
1891 Mar. 21 R1903 Mar. 21	TAYLOR, H. W., Assoc. M. Inst. C.E.	St. Nicholas Chambers, Amen Corner, Newcastle-on-Tyne.
G1898 Dec. 17 TA1902 Jan. 25 T1907 Sept. 7	*TAYLOR, J.	Borough Engineer, Walsall.
G1900 Dec. 15 TA1903 May 16 T1907 May 25	*TAYLOR, P.	Surveyor to the Urban District Council, Hampton Wick.
1890 Sept. 13	TAYLOR, T. G.	Borough Surveyor, Ramsgate.
G1891 Sept. 12 T1897 Oct. 16	*TAYLOR, W. J., M. Inst. C.E.	County Surveyor, Hants. Winchester.

Date of Election and Transfer.		
1892 Apr. 23	TERRILL, W.	Surveyor to the Urban District Council, Ashford, Kent.
1892 Mar. 11	*THOMAS, R. J., M. Inst. C.E. (*Member of Council.*)	County Surveyor, Bucks. Aylesbury.
1890 May 3	THOMAS, T. J., A.M.Inst.C.E.	Surveyor to the Urban District Council, Ebbw Vale.
1902 May 10	THOMAS, W. B.	Surveyor to the Urban District Council, Southwick-on-Wear.
1887 Sept. 17	THOMAS, W. E. C., A.M. Inst. C.E. (*Member of Council.*)	Surveyor to the Rural District Council, Neath. *Hon. Secretary*, South Wales District.
1906 Nov. 3	THOMSON, J.	City Engineer, Dundee.
G1904 June 25 T1906 Nov. 3	THORP, W. O.	Surveyor to the Urban District Council, Malvern.
1891 Jan. 21	THORPE, J.	Surveyor to the Rural District Council, Macclesfield.
1898 Jan. 15	THROPP, J., M. Inst. C.E. ..	County Surveyor, Lincolnshire. 29 Broadgate, Lincoln.
1898 Apr. 23	THWAITES, W., M. Inst. C.E.	Chief Engineer to the Metropolitan Board of Works, Melbourne, Australia.
G1898 June 30 T1903 Dec. 12	*TIFFIN, T. E, A.M.Inst.C.E.	Surveyor to the Urban District Council, Dartford, Kent.
G1891 June 6 T1893 Oct. 21	*TOMES, G. B., A.M. Inst. C.E.	Surveyor to the Urban District Council, Barnes, Mortlake.
1895 Mar. 16	TOOLEY, H.	Surveyor to the Urban District Council, Buckhurst Hill, Essex.
1890 May 3	TOWLSON, S., A.M. Inst. C.E.	Surveyor to the Urban District Council, Sevenoaks.
1894 Oct. 20	TRAVERS, W. H.	Surveyor to the Urban District Council, Wallasey.
1897 Jan. 16	TRESSIDER, W. H...	Borough Surveyor, Falmouth.
1901 Feb. 16	TROWSDALE, T. J.	Surveyor to the Urban District Council, Annfield Plain. Hare Law, Annfield Plain, Co. Durham.
1893 Oct. 21	TURLEY, A. C., Assoc.M.Inst. C.E.	City Engineer, Canterbury.
1890 Oct. 18	TURNBULL, A. J.	Burgh Surveyor, Greenock, N.B.
1897 Mar. 13	TURNER, H. H	Surveyor to the Rural District Council, Limehurst, Lancs. 250 Oldham Road, Waterloo, near Ashton-under-Lyne.
1899 June 10	*TURNER, S.	Surveyor to the Rural District Council, Ashby-de-la-Zouche.
1898 June 30	TURRIFF, A. A.	Burgh Surveyor, Elgin, N.B.
1905 May 27	*UREN, F. C.	Surveyor to the Urban District Council, Aldershot.
1889 Sept. 21	VALLANCE, R. F.	Borough Surveyor, Mansfield.
1887 Oct. 22	VALON, W. A. McINTOSH, Assoc. M. Inst. C.E.	Ramsgate Corporation Gas-works Engineer. 140 and 141 Temple Chambers, Temple Avenue, E.C.

Date of Election and Transfer.		
E1894 Jan. 13 T1901 Dec. 7 R1903 Feb. 21	*VEIT, L. J.	1 Pimlico Road, S.W.
1889 Sept. 21 R1903 Jan. 17	VENTRIS, A., Assoc. M. Inst. C.E.	160 Buckingham Palace Road, S.W.
1897 June 19	VINCENT, S. J. L., A. M. Inst. C.E.	Borough Surveyor, Newbury.
1894 June 21	WADDINGTON, J. A. P., M. Inst. C.E.	Borough Engineer, Marylebone, W.
1902 June 7	WAKEFORD, J. P., A. M. Inst. C.E.	Surveyor to the Urban District Council, Bilston.
1888 July 12	WAKELAM, H. T., M. Inst. C.E. (*Member of Council.*)	County Engineer, Middlesex. Guildhall, Westminster, S.W.
1898 Sept. 3	WALKER, A. H., A. M. Inst. C.E.	Borough Surveyor, Loughborough.
E1900 Dec. 15 T1904 Jan. 23	*WALKER, H.	Surveyor to the Urban District Council, Wealdstone.
1887 June 18	WALSHAW, J. W.	Borough Surveyor, Peterborough.
1905 Sept. 23	WARBURTON, W. E.	Surveyor to the Urban District Council, Hornsea.
1899 Jan. 21	WARD, J., M. Inst. C.E. ..	Borough Engineer, Derby.
1904 Jan. 23	WARD, T., Assoc. M. Inst. C.E.	Borough Engineer, Lower Hutt. 4 Grey Street, Wellington, New Zealand.
1886 July 8	WARDLE, J. W., A.M.Inst.C.E.	Borough Surveyor, Longton.
E1900 May 19 T1905 Mar. 3	*WARLOW, W. R.	Surveyor to the Urban District Council, Milton-next-Sittingbourne.
E1904 May 28 T1904 Sept. 17	*WARR, G. W.	Surveyor to the Urban District Council, Southwick.
1890 May 3	WATERHOUSE, D.	Surveyor to the Urban District Council, Watford.
1892 Mar. 11	WATKEYS, G., A.M.Inst.C.E.	Surveyor to the Urban District Council, Llanelly.
1887 June 18	WATSON, J. D., M. Inst. C.E.	Engineer to the Birmingham, Tame and Rea Drainage Board, Council House, Birmingham.
1904 Aug. 10	WATSON, W.	Burgh Surveyor, St. Andrews, N.B.
1889 Sept. 21	WATTS, E. T.	Surveyor to the Rural District Council, Hadham and Stansted, Bishop's Stortford.
1893 Oct. 21	WATTS, W., M.Inst. C.E. ..	Kenmore, Wilmslow, Cheshire.
1887 June 18	WEAVER, W., M. Inst. C.E. (*Past President.*)	30 Lytton Grove, Putney Hill, S.W.
1897 Feb. 13	WEBB, J. A.	Surveyor to the Rural District Council, Hendon. Great Stanmore.
1905 Oct. 28	WEBB, J. H.	Borough Surveyor and Water Engineer, King's Lynn.
1901 Oct. 19	WEBSTER, J. W.	Surveyor to the Urban District Council, Cowes, Isle of Wight.
1905 Jan. 28	WEBSTER, R. A.	Town Engineer, Krugersdorp, Transvaal, S.A.

Date of Election and Transfer.		
1895 May 25 R1901 Aug. 24	WEBSTER, R. J.	District Surveyor, Castleton, Manchester.
1882 Apr. 15	WELBURN, W.	Borough Surveyor, Middleton, near Manchester.
1907 Sept. 7	WELLER, A.	Borough Engineer, Brighton.
1887 June 18 R1903 Feb. 21	WESTON, G.	The Limes, Harrow Road, Pinner.
1889 Apr. 13 R1903 Jan. 17	WESTON, H. J., Assoc. M. Inst. C.E.	24 Portland Street, Southampton.
1907 May 25	WHEELER, A. G.	Surveyor to the Urban District Council, Eastwood.
P1888 July 12	WHITE, A. E., M. Inst. C.E. .. (*Member of Council.*)	City Engineer, Hull.
1891 Oct. 17	WHITE, H. V., M. Inst. C.E. I.	County Surveyor, Queen's County, Maryborough.
1900 Mar. 10	WHITE, J. N.	Borough Surveyor, Stalybridge.
1873 May 2	WHITE, W. H., M. Inst. C.E. (*Past President.*)	City Engineer, Oxford.
1899 Mar. 25	WHITTELL, F. S.	Surveyor to the Urban District Council, Worksop.
1900 Aug. 25	WHYATT, H. G., A. M. Inst. C.E.	Borough Engineer, Great Grimsby.
1889 Feb. 9	WIKE, C. F., M. Inst. C.E. (*Vice-President.*)	City Surveyor, Sheffield.
1888 May 12	WILD, G. H.	Surveyor to the Urban District Council, Littleborough, near Manchester.
1896 Apr. 25	WILDING, J.	Surveyor to the Urban District Council, Runcorn.
1905 June 22	WILES, J. W.	Surveyor to the Urban District Council, Gorton, Lancs.
1884 May 29 R1902 Nov. 8	WILKINSON, J. P., M. Inst. C.E.	301–304 Corn Exchange Chambers, Cathedral Street, Manchester.
1899 Mar. 25	WILKINSON, M. H.	Surveyor to the Urban District Council, Leyland.
1899 Feb. 25 R1903 Mar. 21	WILKINSON, W.	Ashton House, Hemingbrough, E. Yorks.
1884 Oct. 9 R1885 June 6	WILLCOX, J. E., M. Inst. C.E.	63 Temple Row, Birmingham.
1894 Mar. 3	WILLIAMS, H. DAWKIN	Surveyor to the Urban District Council, Ogmore and Garrw, Blackmill R.S.O., Bridgend.
1904 May 28	WILLIAMS, J.	Surveyor to the Urban District Council, Abercarn, Mon.
1893 July 31	WILLIAMS, J. B.	Borough Surveyor, Daventry.
1897 May 15	WILLIAMS, M.	Coychurch, Bridgend.
1907 Mar. 2	WILLIAMS, T. T.	Surveyor to the Rural District Council, Swansea.
1904 Aug. 4	WILLIAMSON, W.	City Engineer's Office, Glasgow.
1891 June 25	WILLMOT, J.	County Surveyor, Warwickshire. 6 Waterloo Street, Birmingham.
1904 Oct. 29	WILLOUGHBY, P. R. A., A.M. Inst. C.E.	Surveyor to the Urban District Council, Pontypridd.
1898 June 30	WILSON, A.	County Surveyor, Dumbartonshire.
1887 Sept. 17	WILSON, G.	Surveyor to the Urban District Council, Alnwick.

Date of Election and Transfer.		
1873 May 2 R1899 Feb. 25	WILSON, J.	Bankside, Bacup, Lancashire.
1884 May 29	*WILSON, J. B., A.M. Inst. C.E.	Surveyor to the Rural District Council, Cockermouth.
1904 Aug. 23	WILSON, J. R.	Burgh Surveyor, Helensburgh, N.B.
1907 Apr. 27	WILSON, W.	Town Surveyor, Portadown, Ireland.
1897 Oct. 16	WINNING, D.	Burgh Surveyor, Broughty Ferry, N.B.
1880 Oct. 2	WINSHIP, G., A.M. Inst. C.E.	Borough Surveyor, Abingdon, Berks.
1896 Feb. 22	WINTER, O. E., Assoc. M. Inst. C.E.	Borough Surveyor, Hampstead, N.W.
G1900 May 19 TA1902 Jan. 25 T1902 Nov. 8	*WOLFENDEN, B. J., A.M.Inst. C.E.	Borough Engineer, Bootle.
1880 Feb. 7	WOOD, A. R.	Surveyor to the Urban District Council, Tunstall.
1894 Mar. 3	WOOD, F. J., A. M. Inst. C.E.	County Surveyor, Sussex East. Lewes.
1898 Apr. 23	WOOD, W. E.	Surveyor to the Urban District Council, Church.
1900 Feb. 10	WOODS, E. L.	Town Surveyor, Bangor, Co. Down.
1885 Oct. 3 R1903 Feb. 21	WOODBRIDGE, C. A.	Pinner House, Pinner, Middlesex.
1899 May 6	WOODWARD, F.	Surveyor to the Urban District Council, Stourbridge.
G1900 July 19 T1901 Oct. 19	*WOOTTON, A. S.	Surveyor, Urban District Council, Bradford-on-Avon.
1897 July 8	*WORRALL, E.	Surveyor to the Urban District Council, Stretford, Council Offices, Old Trafford.
1886 July 8	WORTH, J. E., M. Inst. C.E.	District Engineer, London County Council, Spring Gardens, S.W.
G1893 July 13 T1899 Oct. 21 R1904 Dec. 3	*WRIGHT, J. A.	6 Unity Street, Bristol.
1892 May 28	WYNNE-ROBERTS, R. O., M. Inst. C.E.	5 Victoria Street, Westminster, S.W.
1895 Jan. 19	YABBICOM, T. H., M.Inst. C.E. (*Past President.*) (*Member of Council.*)	City Engineer, Bristol.
G1892 July 11 T1892 Sept. 24	*YATES, F. S., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, Waterloo, near Liverpool.
1894 June 21	YORK, H., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, East Barnet Valley. Station Road, New Barnet.
1904 Aug. 26	YOUNG, C.	Burgh Surveyor, Coatbridge, N.B.
p1900 May 19	YOUNG, J.	Burgh Surveyor, Ayr.
1899 Dec. 16	YOUNG, T.	Surveyor to the Rural District Council, Sunderland.
1900 May 19	YOUNG, W. P.	Surveyor to the Rural District Council, Wallsall.

ASSOCIATE MEMBERS.

Date of Election and Transfer.		
A1906 Dec. 15 TAM1907 Nov. 2	BELSHER, B. J.	Deputy Borough Engineer, Stepney.
G1898 June 30 A1901 Oct. 19 TAM1907 Nov. 2	*BEST, H. STORR	Chief Assistant Surveyor, Urban District Council, Beckenham.
1907 Sept. 7	*CHART, R.	Chief Assistant Surveyor, Rural District Council, Croydon.
A1905 May 27 TAM1907 Sept. 7	COLLINS, H., A. M. Inst. C.E.	Deputy City Engineer, Norwich.
G1898 Jan. 15 A1903 Jan. 17 TAM1907 Nov. 2	*GODFREY, C. H., A. M. Inst. C.E.	Deputy Engineer, Shanghai Municipality.
1907 Sept. 7	GOODWIN, J. D.	Borough Engineer, Ashfield, N.S.W.
G1900 June 16 A1901 Oct. 19 TAM1907 Nov. 2	*JERRAM, G., A. M. Inst. C.E.	Assistant Surveyor, Walthamstow.
G1895 Oct 19 TAM1907 Nov. 2	*JULIAN, J.	Deputy Borough Engineer, Cambridge.
1907 Sept. 7	LANE, W. G.	Surveyor, Urban District Council, Tavistock.
1907 Sept. 7	RICHARDSON, H.	Deputy Borough Surveyor, Scarborough.
1907 Sept. 7	SIMS, S. B.	Borough Engineer, Hamilton, N.Z.
A1907 Jan. 19 TAM1907 Nov 2	SNODGRASS, R., A.M.Inst.C.E.	Deputy Borough Engineer, Guildford.
G1895 Jan. 19 A1901 Oct. 19 TAM1907 Nov. 2	*STEELE, W. J., A.M.Inst.C.E.	Deputy City Engineer, Bristol.
G1898 June 30 TAM1907 Nov. 2	*SUTTON, W. F.	Chief Assistant, Birmingham Water Supply. Water Offices, Broad Street, Birmingham.
A1905 Sept. 23 TAM1907 Nov. 2	SWARBRICK, G.	Deputy Borough Surveyor, Swansea.
G1900 June 16 TAM1907 Sept. 7	*TOWNER, H. V.	Acting Superintendent, Works and Surveys, P.W.D., Singapore.

TOWNS AND DISTRICTS

REPRESENTED BY MEMBERS AND ASSOCIATE MEMBERS OF THE ASSOCIATION.

A.	*signifies* Abroad.	Met.	*signifies*	Metropolitan District.
Af.	„ African District.	M.	„	Midland District.
E.	„ Eastern District.	N.	„	Northern District.
H.	„ Home District.	S.	„	Scottish District.
Ind.	„ Indian District.	W.N.	„	Welsh District (North).
I.	„ Irish District.	W.S.	„	„ „ (South).
L. & C.	„ Lancashire & Cheshire District.	West.	„	Western District.
		Y.	„	Yorkshire District.

TOWN.	DISTRICT.	NAME.
Abercarn	West.	J. Williams.
Aberdeen	S.	W. Dyack.
Abergavenny	West.	J. Haigh.
Abingdon	H.	G. Winship.
Abram	L. & C.	G. Heaton.
Accrington	L. & C.	W. J. Newton.
Acton	H.	D. J. Ebbetts.
Aldershot	H.	F. C. Uren.
Alexandria	A.	D. E. Lloyd-Davies.
Alnwick	N.	G. Wilson.
Andover	H.	R. W. Knapp.
Annfield Plain	N.	T. J. Trowsdale.
Antrim (County)	I.	J. H. Brett.
Arbroath, N.B.	S.	P. C. Smith.
Argyllshire (County)	S.	M. B. McBeth.
Armagh	I.	J. C. Boyle.
„ (County)	I.	R. H. Dorman.
Ashby-de-la-Zouch	M.	S. Turner.
Ashfield, N.S.W.	A.	J. D. Goodwin.
Ashford	H.	W. Terrill.
„ (Rural)	H.	A. Sims.
Ashton-under-Lyne	L. & C.	J. T. Earnshaw.
Ashton-on-Mersey	L. & C.	F. Hutton.
Atherstone (Rural)	M.	H. J. Coleby.
Atherton	L. & C.	W. Clough.
„	L. & C.	F. H. Grimshaw.
Athlone (County)	I.	C. J. Mulvany.
Auckland, N.Z.	A.	W. E. Bush.
Audley	M.	T. Bibbey.
Ayr	S.	J. Young.
Ayrshire (County)	S.	A. Stevenson.
Bacup	L. & C.	W. H. Elce.
Balby with Hexthorpe	Y	G. Gledhill.
Ballymena	I.	H. O'Hara.
Banbury	H.	N. H. Dawson.
Bangor, Co. Down	I.	E. L. Woods.
Barking	H.	C. F. Dawson.
Barnes	H.	G. B. Tomes.

TOWN.	DISTRICT.	NAME.
Barnstaple	West.	E. Y. Saunders.
Barrow-in-Furness	L. & C.	J. W. Smith.
Barry	W.S.	J. C. Pardoe.
Barton-upon-Irwell (Rural)	L. & C.	C. C. Hooley.
Basford (Rural)	M.	S. Maylan.
" " (Highways)	M.	G. W. Hawley.
Basingstoke	H.	F. R. Phipps.
Battersea	Met.	T. W. A. Hayward.
Beccles	E.	T. O. Cudbird.
Beckenham	H.	J. A. Angell.
Bedford	H.	N. Greenshields.
Bedford (County)	H.	W. H. Leete.
Belfast	I.	H. A. Cutler.
Belper	M.	T. Fenn.
" (Rural)	M.	R. C. Cordon.
Benwell	N.	W. P. Pattison.
Berkshire (County)	H.	J. F. Hawkins.
Bermondsey	Met.	R. J. Angel.
Berwick-on-Tweed	S.	R. Dickinson.
Berwickshire (County), N.B.	S.	T. R. Atkinson.
Bethnal Green	Met.	E. E. Finch.
Beverley	Y.	J. G. Smith.
" (Rural)	Y.	E. Picker.
Bexhill	H.	G. Ball.
Bexley	H.	W. T. Howse.
Biddulph	M.	S. Gibson.
Biggleswade	H.	T. Cockrill.
" (Rural)	H.	J. O. Jones.
Bilston	M.	J. P. Wakeford.
Bingley	Y.	H. Bottomley.
Birkenhead	L. & C.	C. Brownridge.
Birmingham	M.	H. E. Stilgoe.
Bishop's Castle	M.	A. Hamar.
Bishop's Stortford	H.	R. S. Scott.
Blackburn	L. & C.	W. Stubbs.
Blackpool	L. & C.	J. S. Brodie.
Blackwell (Rural)	M.	H. Silcock.
Bloemfontein, South Africa	Af.	H. F. Peet.
Blyth (Northumberland)	N.	R. Grieves.
Blyth and Cuckney (Rural)	M.	F. Hopkinson.
Bognor	H.	O. A. Bridges.
Bolton	L. & C.	E. L. Morgan.
Bombay	Ind.	J. Hall.
Bo'ness, N.B.	S.	J. P. Lawrie.
Bootle	L. & C.	B. J. Wolfenden.
Boston, Lincs.	E.	G. E. Clarke.
Bournemouth	H.	F. W. Lacey.
Brackley	M.	A. A. Green.
Bradford	Y.	J. H. Cox.
Bradford-on-Avon	West.	A. S. Wootton.
Braintree	E.	H. H. Nankivell.
Brecon	W.	H. Ll. Griffiths.
Brentford	H.	N. Parr.
Bridgwater	West.	F. Parr.
Bridgwater (Rural)	West.	W. A. Collins.
Bridlington	Y.	E. R. Matthews.
" (Rural)	Y.	S. Dyer.
Brierfield	L. & C.	B. Halstead.
Brierley Hill	M.	J. L. Harpur.
Brighouse	Y.	S. S. Haywood.

TOWN.	DISTRICT.	NAME.
Brighton	H.	A. Weller.
Bristol	West.	T. H. Yabbicom.
Briton Ferry	W.S.	H. A. Clarke.
Broadstairs	H.	H. Hurd.
Bromyard	M.	J. D. Barrs.
Broughty Ferry, N.B.	S.	D. Winning.
Brownhills	M.	J. H. Shaw.
Buckhurst Hill	E.	H. Tooley.
Buckingham	H.	J. Smith.
" (County)	H.	R. J. Thomas.
Bucklow (Rural)	L. & C.	J. McD. McKenzie.
Burnham	West.	W. H. Chowins.
Burnley	L. & C.	G. H. Pickles.
" (Rural)	L. & C.	S. Edmondson.
Burslem	M.	F. Bettany.
Burton-on-Trent	M.	G. T. Lynam.
Bury	L. & C.	A. W. Bradley.
Bury St. Edmunds	E.	W. D. Harding.
Buxton	M.	W. H. Grieves.
Caerphilly	W.S.	A. O. Harpur.
Camberwell	Met.	W. Oxtoby.
Cannock, Staffs	M.	J. S. Hendry.
Canterbury	H.	A. C. Turley.
Cape Coast	Af.	D. S. Palk.
Cardiff	W.S.	W. Harpur.
Carlisle	N.	H. C. Marks.
Carlton	M.	J. C. Haller.
Carnarvonshire (County)	W.N.	E. Evans.
"	W.N.	E. Hall.
Castleford	Y.	W. Green.
Chatham	H.	C. Day.
Chelmsford	E.	C. Brown.
" (Rural)	E.	J. Dewhirst.
Chelsea	Met.	T. W. E. Higgens.
Cheltenham	West.	J. S. Pickering.
Cheriton	H.	A. O. Sherren.
Chesham	H.	P. C. Dormer.
Cheshire (County)	L. & C.	H. F. Bull.
Cheshunt	H.	R. H. Jeffes.
Chester	L. & C.	I. M. Jones.
Chesterfield	M.	V. Smith.
" (Rural)	M.	E. Lines.
Chesterton	E.	J. D. Bland.
" (Rural)	E.	J. Dunn.
Chichester	H.	F. J. Lobley.
Chippenham	West.	A. E. Adams.
Chorley	L. & C.	W. Leigh.
Christchurch	H.	E. I. Legg.
Church	L. & C.	W. E. Wood.
Clayton-le-Moors	L. & C.	A. Dodgeon.
Cleckheaton	Y.	C. Lund.
Cleethorpes	E.	E. Rushton.
Coalville	M.	L. L. Baldwin.
Coatbridge, N.B.	S.	C. Young.
Cockermouth	N.	F. O. C. Nash.
Cockermouth (Rural)	N.	J. B. Wilson.
Colchester	E.	H. Goodyear.
Colne	L. & C.	T. H. Hartley.

TOWN.	DISTRICT.	NAME.
Colombo, Ceylon	Ind.	F. A. Cooper.
„ „	Ind.	R. Skelton.
Colwyn Bay	W.N.	W. Jones.
Congleton	L. & C.	R. Burslam.
Consett	N.	W. S. Shell.
Conway (Rural)	W.N.	T. B. Farrington.
Cork	I.	J. F. Delany.
Cork (County), West	I.	R. W. Longfield.
Cottingham	Y.	J. H. Hanson.
Cowes, Isle of Wight	H.	J. W. Webster.
Crewe	L. & C.	G. Eaton-Shore.
Cromer	E.	A. F. Scott.
Croydon	H.	G. F. Carter.
„ (Highways)	H.	E. F. Morgan.
„ (Rural)	H.	R. M. Chart.
„ (Rural) (Highways)	H.	J. S. Killick.
Cumberland (County)	N.	G. J. Bell.
Cupar (Fife) (County)	S.	T. Aitken.
Dartford	H.	T. E. Tiffen.
Dartmouth	West.	T. W. Joyce.
Daventry	M.	J. B. Williams.
Darwen	L. & C.	R. W. Smith-Saville.
Deal	H.	T. C. Golder.
Delhi	Ind.	T. Salkield.
Denton	L. & C.	G. H. Newton.
Derby	M.	J. Ward.
„ (County)	M.	J. W. Horton.
Devon (County)	West.	S. Ingram.
Dewsbury	Y.	H. Dearden.
Doncaster (Rural) (Highways)	Y.	W. Crabtree.
Dorchester	West.	G. J. Hunt.
Dorking	H.	G. S. Mathews.
„ (Rural)	H.	W. Rapley.
Douglas, Isle of Man	L. & C.	F. Cottle.
Dover	H.	W. C. Hawke.
Down (County)	I.	J. Heron.
Driffield (Rural)	Y.	T. C. Beaumont.
Droylsden	L. & C.	C. Hall.
Dublin	I.	S. Harty.
„ (County)	I.	W. Collen.
Dudley	M.	J. Gammage.
Dukinfield	L. & C.	S. Hague.
Dumbartonshire (County)	S.	A. Wilson.
Dundee	S.	J. Thomson.
Dunfermline (County)	S.	D. MacKenzie.
Dunoon, N.B.	S.	J. Andrew.
Dunstable	M.	J. Stewart.
Durham (Rural)	N.	G. Gregson.
Ealing	H.	C. Jones.
East Barnet Valley	H.	H. York.
East Ham	H.	A. H. Campbell.
East Molesey	H.	J. Stevenson.
East Retford (Rural)	M.	T. Henry.
East Stow (Rural)	E.	G. F. P. Harrison.
Eastbourne	H.	A. E. Prescott.
Eastwood	M.	A. G. Wheeler.

TOWN.	DISTRICT.	NAME.
Ebbw Vale	West.	T. J. Thomas.
Eccles	L. & C.	T. S. Picton.
Edinburgh, N.B.	S.	J. Massie.
Elgin, N.B.	S.	A. A. Turriff.
Enfield	H.	R. Collins.
Enniskillen (County)	I.	J. P. Burkitt.
Epsom	H.	E. R. Capon.
Erdington	M.	H. H. Humphries.
Erith	H.	H. Hind.
Eston	Y.	C. McDermid.
Eton (Rural)	H.	R. Hallam.
" " (Highways)	H.	A. Gladwell.
Evesham	M.	B. C. Mawson.
Exeter	West.	T. Moulding.
Exmouth	West.	S. Hutton.
Falmouth	West.	W. H. Tressider.
Falkirk, N.B.	S.	D. Ronald.
Fareham	H.	W Butler.
Farnborough	H.	J. E. Hargreaves.
Farnham	H.	R. W. Cass.
Faversham	H.	S. P. Andrews.
Fenny Stratford	H.	J. Chadwick.
Finchley	H.	C. J. Jenkin.
Finsbury	Met.	P. G. Killick.
Flintshire (County)	W.N.	S. Evans.
Folkestone	H.	A. E. Nichols.
Foot's Cray	H.	W. A. Farnham.
Friern Barnet	H.	E. J. Reynolds.
Frimley	H.	T. C. Jones.
Frinton-on-Sea	E.	E. M. Bate.
Frome	West.	F. W. Jones.
Gainsborough	E.	S. W. Parker.
Gateshead	N.	N. P. Pattinson.
Gillingham	H.	J. L. Redfern.
Glamorgan (County)	W.S.	G. A. Phillips.
Glasgow, N.B.	S.	A. B. McDonald.
Glasgow, N B.	S.	T. Nisbet.
Glastonbury	West.	G. Alves.
Gloucester	West.	R. Read.
" (County)	West.	B. Phillips.
Glyncorrwg	W S.	W. P. Jones.
Godalming	H.	J. H. Norris.
Godstone (Rural)	H.	J. George-Powell.
Goole	Y.	E. H. Barber.
Gorton	L. & C.	J. W. Wiles.
Gosforth	N.	G. Nelson
Gosport and Alverstoke	H.	H. Frost.
Govan, N.B.	S.	F. G. Holmes.
Grantham	E.	W. Shackleton.
Gravesend	H.	F. T. Grant.
Grays Thurrock	H.	A. C. James.
Great Crosby	L. & C.	W. Hall.
Great Grimsby	E.	H. G. Whyatt.
Great Yarmouth	E.	J. W. Cockrill.
Greenock, N.B.	S.	A. J. Turnbull.
Grey County, New Zealand	A.	J. Higgins.
Greymouth, New Zealand	A.	E. I. Lord.

TOWN.	DISTRICT.	NAME.
Guernsey	H.	T. J. Guilbert
Guildford	H.	C. G. Mason.
„ (Rural)	H.	J. Anstee.
Hackney	Met.	N. Scorgie.
Hadham and Stansted	H.	E. T. Watts.
Halifax (Rural)	Y.	F. Gordon.
Hamilton, N.B.	S.	W. H. Purdie.
Hamilton, N.Z.	A.	S. B. Sims.
Hammersmith	Met.	H. Mair.
Hampstead	Met.	O. E. Winter.
Hampton-on-Thames	H.	S. H. Chambers.
Hampton Wick	H.	P. Taylor.
Handsworth	M.	H. Richardson.
Hanley	M.	J. Lobley.
Hants (County)	H.	W. J. Taylor.
Hanwell	H.	S. W. J. Barnes.
Harrow	H.	J. P. Bennetts.
Harwich	E.	H. Ditcham.
Haslingden	L. & C.	J. S. Green.
Hastings	H.	P. H. Palmer.
Haverhill	E.	F. W. Knewstubb.
Hawick, N.B.	S.	Chas. Brown.
Hayes	H.	C. C. Gray.
Heckmondwike	Y.	J. Saville.
Helensburgh, N.B.	S.	J. R. Wilson.
Hemel Hempstead	M.	W. R. Locke.
Hendon	H.	S. S. Grimley.
„ (Rural)	H.	J. A. Webb.
Hengoed (Rural)	W.S.	J. P. Jones.
Hereford	M.	J. Parker.
„ (County)	M.	G. H. Jack.
Herne Bay	H.	F. W. J. Palmer.
Hertford	H.	J. H. Jevons.
Hertfordshire (Highways)	H.	E. Parry.
Heysham	L. & C.	H. Miller.
Heywood	L. & C.	J. A. Settle.
High Wycombe	H.	T. J. Rushbrooke.
Hinckley	M.	E. H. Crump.
Hitchin	H.	A. T. Blood.
Holborn	Met.	E. F. Spurrell.
Holyhead	W.N.	A. Asquith.
Hornsea	Y.	W. E. Warburton.
Hornsey	H.	E. J. Lovegrove.
Horsforth	Y.	R. R. Jones.
Horsham	H.	R. Renwick.
Hove	H.	H. H. Scott.
Howrah, Bengal	Ind.	A. Hale.
Hoylake and West Kirby	L. & C.	R. W. Fraser.
Hoyland	Y.	H. G. Keywood.
Huddersfield	Y.	K. F. Campbell.
„ (Gas)	Y.	E. A. Harman.
Hull	Y.	A. E. White.
Huntingdon (County)	M.	H. J. G. Leete.
Hutt County, N.Z.	A.	A. W. Newton.
Hyde	L. & C.	J. Mitchell.
Hythe	H.	Chris. Jones.
Ilford	E.	H. Shaw.
Ilfracombe	West.	O. M. Prouse.

TOWN.	DISTRICT.	NAME.
Inglewood, N.Z.	A.	L. G. P. Spencer.
Inverness	S.	T. H. Scott.
Ipswich	E.	E. Buckham.
Irlam	L. & C.	G. H. Kay.
Ipswich, Queensland	A.	T. Kirk.
Isle of Ely, North (County)	E.	H. F. Simpson.
Isle of Thanet (Rural)	H.	G. L. Butterworth.
Islington	Met.	J. P. Barber.
Itchen	H.	T. A. Collingwood.
Johannesburg	Af.	A. P. Lambert.
Kearsley	L. & C.	H. Nuttall.
Keighley	Y.	W. Fowlds.
Kenilworth	M.	S. Douglas.
Kensington	Met.	A. R. Finch.
Kent (County)	H.	H. P. Maybury.
Kesteven (County)	E.	W. B. Purser.
Keswick	N.	W. Hodgson.
Kettering	M.	T. R. Smith.
Keynsham (Rural)	West.	H. M. Bennett.
Kidderminster (Rural)	M.	A. Comber.
Kilkenny (County)	I.	A. M. Burden.
Kilmarnock, N.B.	S.	R. Blackwood.
King's Lynn	E.	J. H. Webb.
King's Norton	M.	A. W. Cross.
Kingston, Jamaica	A.	C. V. Abrahams.
Kingston-on-Thames	H.	R. H. Clucas.
King Williamstown, S.A.	Af.	J. Maden.
Kirkcaldy	S.	J. L. Lumsden.
Kirriemuir, N.B.	S.	J. S. Bruce.
Kroonstad, O.R.C.	Af.	F. Brown.
Krugersdorp, Transvaal	Af.	R. A. Webster.
Lagos	Af.	I. T. Hawkins.
Lambeth	Met.	H. C. J. Edwards.
Lanark (County)	S.	W. L. Douglass.
Lancashire (County)	L. & C.	W. H. Schofield.
Lancaster	L. & C.	J. C. Mount.
Lanchester (Rural) (Highways)	N.	W. Cumming.
Leatherhead	H.	J. E. Smales.
Leeds	Y.	W. T. Lancashire.
Leeds (Sewerage)	Y.	G. A. Hart.
Leek	M.	W. E. Beacham.
Leicester	M.	E. G. Mawbey.
" (County)	M.	S. P. Pick.
Leigh	L. & C.	T. Hunter.
" (Rural)	L. & C.	T. W. B. Gent.
Leigh-on-Sea	E.	J. W. Liversedge.
Leith, N.B.	S.	J. R. Findlay.
Leitrim (County)	I.	E. O'N. Clarke.
Levenshulme	L. & C.	J. Jephson.
Lewisham	Met.	E. Van Putten.
Leyland	L. & C.	W. H. Wilkinson.
Leyton	H.	W. Dawson.
Lichfield	M.	W. B. Chancellor.
Limehurst (Rural)	L. & C.	H. H. Turner.
Limerick (County)	I.	J. Horan.

TOWN.	DISTRICT.	NAME.
Lincoln	E.	R. A. MacBrair.
„ (County)	E.	J. Thropp.
Linlithgow (Highways)	S.	A. Forbes.
Litherland	L. & C.	A. H. Carter.
Littleborough	L. & C.	G. H. Wild.
Littlehampton	H.	H. Howard.
Little Woolton	L. & C.	R. Simmons.
Liverpool	L. & C.	J. A. Brodie.
Llandaff (Rural)	W.S.	J. Holden.
Llandudno	W.N.	E. P. Stephenson.
Llanelly.	W.S.	G. Watkeys.
Llantrissant (Rural)	W.S.	G. S. Morgan.
Loftus	Y.	T. H. Tarbit.
London	Met.	F. Sumner.
„ (County)	Met.	M. Fitzmaurice.
Londonderry	I.	W. J. Robinson.
Londonderry (County)	I.	C. L. Boddie.
Longford (County)	I.	J. W. Gunnis.
Longton	M.	J. W. Wardle.
Loughborough	M.	A. H. Walker.
Louth (County)	I.	P. J. Lynam.
Lower Bebington	L. & C.	H. W. Corrie.
Lower Hutt, N.Z.	A.	T. Ward.
Lowestoft	E.	G. H. Hamby.
Lucknow (United Provinces)	Ind.	H. Lane Brown.
Ludlow	West.	J. A. Spreckley.
Lurgan	I.	H. Shillington.
Luton	M.	S. F. L. Fox.
Lymington	H.	F. H. Parr.
Lytham	L. & C.	A. J. Price.
Macclesfield (Rural)	L. & C.	J. Thorpe.
Maesteg	W.S.	J. Humphreys.
Maidstone	H.	T. F. Bunting.
Maldon	E.	T. R. Swales.
Malvern	M.	W. O. Thorp.
Manchester	L. & C.	T. De C. Meade.
Mansfield	M.	R. F. Vallance.
Mansfield Woodhouse	M.	F. P. Cook.
Margam, Port Talbot	W.S.	J. Cox.
Margate	H.	E. A. Borg.
Market Harborough	M.	H. G. Coales.
Marple	L. & C.	D. J. Diver.
Marylebone	Met.	J. A. P. Waddington.
Matlock	M.	J. Diggle.
Matlock Bath	M.	W. Jaffrey.
Maxwelltown, N.B.	S.	J. McL. Bowie.
Melbourne	A.	W. Thwaites.
Melford (Rural)	E.	W. Carver.
Melton Mowbray	M.	E. Jeeves.
Merthyr Tydvil	W.S.	T. F. Harvey.
Methley	Y.	T. W. Nichols.
Mexborough	Y.	G. F. Carter.
Middlesbrough	Y.	F. Baker.
Middlesex (County)	H.	H. T. Wakelam.
Middleton	L. & C.	W. Welburn.
Midhurst (Rural)	H.	A. G. Gibbs.
Midsomer Norton	West.	C. H. Sunderland.

TOWN.	DISTRICT.	NAME.
MILTON-NEXT-SITTINGBOURNE ..	H.	W. R. Warlow.
MINEHEAD	West.	J. H. Wooton-Smith.
MONMOUTHSHIRE (County)	West.	W. Tanner.
MONTGOMERY	W.N.	W. P. Hole.
MONTROSE, N.B.	S.	S. L. Christie.
MORLEY	Y.	W. E. Putman.
MUSSELBURGH, N.B.	S.	G. Landale.
NANTYGLO AND BLAINA	West.	W J. Davies.
NEATH	W.S.	D. M. Jenkins.
„ (Rural)	W.S.	W. E. C. Thomas
NELSON	L. & C.	B. Ball.
NESTON	L. & C.	C. E. Senior.
NEW MALDEN	H.	T. B Simmonds.
NEW SWINDON	H.	H. J. Hamp.
NEWARK	M.	G. Sheppard.
„ (Rural)	M.	R. Oakden.
NEWBURN-ON-TYNE	N.	T. Gregory.
NEWBURY	H.	S. J. L. Vincent.
NEWCASTLE-ON-TYNE	N.	C. R. S. Kirkpatrick.
NEWHAVEN	H.	F. J. Rayner.
NEWMARKET	E.	J. W. Metcalf.
NEWPORT, MON.	West.	R. H. Haynes.
NEWRY	I.	C. Blaney.
NEWTON ABBOT	West.	L. Stevens.
NEWTOWN ST. BOSWELLS, N.B. ..	S.	G. Monteath.
NORTHAMPTON	M.	A. Fidler.
NORTHUMBERLAND (County) ..	N.	J. A. Bean.
NORTHWICH	L. & C.	J. Brooke.
NORWICH	E.	A. E. Collins.
NOTTINGHAM	M.	A. Brown.
„ (County)	M.	E. P. Hooley.
NUNEATON	M.	F. C. Cook.
OAKHAM (Rural)	E.	C. W. Maudsley.
OAKWORTH	Y.	J. Spencer.
OGMORE AND GARRW	W.S.	H. D. Williams.
OLDBURY	M.	T. H. Shipton.
OSWESTRY	M.	G. W. Lacey.
OTLEY	Y.	J. E. Sharp.
OXFORD	H.	W. H. White.
OXFORDSHIRE (County)	H.	S. Stallard.
PADDINGTON	Met.	E. B. Newton.
PADIHAM	L. & C.	J. Gregson.
PAIGNTON	West	C. O. Baines.
PAISLEY, N.B.	S.	J. Lee.
PARTICK, N.B.	S.	J. Bryce.
PEEBLES (County)	S.	R. S. Anderson.
PEMBERTON	L. & C.	G. Heaton.
PENANG, S. S.	A.	L. M. Bell.
PENARTH	W.S.	E. I. Evans.
PENGE	H.	H. W. Longdin.
PENRITH	N.	J. J. Knewstubb.
PENRYN	West.	J. P. Jenkins.

TOWN.	DISTRICT.	NAME.
Perth, N.B.	S.	R. McKillop.
Perth, West Australia	A.	H. T. Haynes.
Peterborough	M.	J. W. Walshaw.
Plymouth	West.	J. Paton.
Pollokshaws, N.B.	S.	D. Burns.
Pontardawe (Rural)	W.S.	J. Morgan.
Pontefract	Y.	J. E. Pickard.
Pontypridd	W.S.	P. R. A. Willoughby.
Poole	W.	S. J. Newman.
Portadown	I.	W. Wilson.
Port Elizabeth, South Africa	Af.	A. S. Butterworth.
Port Glasgow, N.B.	S.	J. Murray.
Portishead	West.	F. H. Smith.
Portland	West.	R. S. Henshaw.
Portslade-by-Sea	H.	A. T. Allen.
Portsmouth	H.	P. Murch.
Prahran, Victoria	A.	W. Calder.
Queen's County	I.	H. V. White.
Queenstown, South Africa	Af.	W. A. Palliser.
Ramsbottom	L. & C.	T. H. Bell.
Ramsgate	H.	T. G. Taylor.
Rangoon	A.	L. P. Marshall.
Rawmarsh	Y.	J. Bourne.
Rawtenstall	L. & C.	J. Johnston.
Redcar	Y.	J. Howcroft.
Redditch	M.	A. J. Dickinson.
Reigate	H.	F. T. Clayton.
Renfrewshire (County), N.B.	S.	J. Murray.
Retford	M.	J. D. Kennedy.
Rhondda	W.S.	W. J. Jones.
Rhymney	West.	W. L. Marks.
Richmond, Surrey	H.	J. H. Brierley.
Richmond, Yorks	Y.	T. H. Hailstone.
Rochdale	L. & C.	S. S. Platt.
Rochester	H.	W. Banks.
Rochford (Rural)	H.	H. T. Sidwell.
Rowley Regis	M.	W. H. Brettell.
Rugeley	M.	W. E. Rogers.
Runcorn	L. & C.	J. Wilding.
,, (Rural)	L. & C.	W. Diggle.
Rushden	M.	W. B. Madin.
Rutherglen, N.B.	S.	S. McBride.
Rutland (County)	E.	J. Richardson.
Ryton-on-Tyne	N.	J. P. Dalton.
Saffron Walden	E.	A. H. Forbes.
St. Albans	H.	G. Ford.
St. Andrews, N.B.	S.	W. Watson.
St. Pancras	Met.	W. N. Blair.
Sale	L. & C.	W. Holt.
Salford	L. & C.	J. Corbett.
Saltburn-by-the-Sea	Y.	G. S. L. Bains.

TOWN.	DISTRICT.	NAME.
Scarborough	Y.	H. W. Smith.
„ (Rural)	Y.	J. A. Iveson
Sedgfield, Co. Durham	N.	J. Stones.
Selkirk, N.B.	S.	J. Pritty.
Sevenoaks	H.	S. Towlson.
Shanghai, China	A.	C. Mayne.
Shanklin	H.	E. C. Cooper.
Sheffield	Y.	C. F. Wike.
Shepton Mallet	West.	D. Hinchcliff.
Sherborne	West.	T. Farrall.
Sheringham	E.	F. Hall Smith.
Shrewsbury	M.	W. C. Eddowes.
Shropshire (County)	M.	A. T. Davis.
Singapore	A	R. Peirce.
Skelton-in-Cleveland	Y.	W. P. Robinson.
Skipton	Y.	J. Mallinson.
„ (Rural)	Y.	A. Rodwell.
Slough	H.	W. W. Cooper.
Smallthorne	M.	J. Deane.
Smethwick	M.	C. J. Fox-Allin.
Solihull (Rural)	M.	A. E. Currall.
Soothill Upper	Y.	J. Blackburn.
South Shields	N.	S. E. Burgess.
Southall Norwood	H.	R. Brown.
Southampton	H.	J. A. Crowther.
Southend-on-Sea	H.	E. J. Elford.
Southgate	H.	C. G. Lawson.
Southowram	Y.	W. H. D. Horsfall.
Southport	L. & C.	R. P. Hirst.
Southwark	Met.	A. Harrison.
Southwick	H.	G. W. Warr.
Southwick-on-Wear	N.	W. B. Thomas.
Spalding (Rural)	E.	T. J. Peacock.
Spilsby (Rural)	E.	T. A. Busbridge.
Stafford	M.	W. Blackshaw.
„ (County) (Highways)	M.	J. Moncur.
Staines	H.	E. J. Barrett.
„ (Rural)	H.	G. W. Manning.
Stalybridge	L. & C.	J. N. White.
Stamford	E.	F. R. Ryman.
Stepney	Met.	M. W. Jameson.
Stirling	S.	A. H. Goudie.
Stockport	L. & C.	J. Atkinson.
Stockton-on-Tees	N.	M. H. Sykes.
Stoke-on-Trent	M.	A. Burton.
Stoke Newington	Met.	W. F. Loveday.
Stone	M.	A. R. Ridout.
Stourbridge	M.	F. Woodward.
Stratford-on-Avon	M.	R. Dixon.
Stretford	L. & C.	E. Worrall.
Stroud	West.	G. P. Milnes.
Sudbury	E.	W. I. Tait.
Suffolk (County), East	E.	H. Miller.
Sunbury-on-Thames	H.	H. F. Coales.
Sunderland (Rural)	N.	T. Young.
Surbiton	H.	H. T. Mather.
Surrey (County)	H.	F. G. Howell.
Sussex (County), East	H.	F. J. Wood.
Sutton	H.	C. C. Smith.
Sutton Coldfield	M.	W. A. H. Clarry.

TOWN.	DISTRICT.	NAME.
Sutton-in-Ashfield	M.	W. Burn.
Swadlincote	M.	T. Kidd.
Swanage	West.	J. S. Senior.
Swansea	W.S.	G. Bell.
„ (Rural)	W.S.	T. T. Williams.
Swinton	L. & C.	H. Entwisle.
Sydney, New South Wales	A.	J. M. Smail.
Tadcaster (Rural)	Y.	T. Scott.
Tamworth	M.	F. E. G. Bradshaw.
„ (Rural)	M.	H. J. Clarson.
Tanfield	N.	R. Heslop.
Taunton (Rural)	West.	T. Goldsworthy-Crump.
Tavistock	West.	W. G. Lane.
Teddington	H.	M. Hainsworth.
Teignmouth	West.	C. F. Gettings.
Tenbury (Rural)	M.	R. W. Jarvis.
Tewkesbury	West.	W. Ridler.
Thornhill	Y.	A. Rothera.
Tientsin, China	A.	A.W.H. Bellingham.
Tipperary (County), South	I.	E. A. Hackett.
Tipton	M.	W. H. Jukes.
Tiverton	West.	J. Siddalls.
Todmorden	Y.	J. A. Heap.
Tokio, Japan	A.	B. Kusakabe.
Tonbridge	H.	W. L. Bradley.
„ (Rural)	H.	F. Harris.
Toowong, Queensland	A.	W. E. Irving.
Toowoomba, Queensland	A.	J. C. Ross.
Tottenham	H.	W. H. Prescott.
Tottington	L. & C.	L. Kenyon.
Towyn	W.N.	R. P. Morgan.
Trowbridge	West.	H. G. N. Lailey.
Truro	West.	M. Lea.
Tunbridge Wells	H.	W. H. Maxwell.
Tunstall	M.	A. R. Wood.
Turton	L. & C.	V. Laithwaite.
Twickenham	H.	F. W. Pearce.
Tyldesley	L. & C.	J. B. Smith.
Tynemouth	N.	J. F. Smillie.
Tyrone (County), North	I.	F. J. Lynam.
„ „ South	I.	J. W. Leebody.
Urmston	L. & C.	J. Heath.
Uxbridge (Rural) (Highways)	H.	E. Birks.
„ (Rural)	H.	J. F. Stow.
Ventnor	H.	H. H. Oakes.
Wakefield	Y.	R. Porter.
„ (Rural)	Y.	F. Massie.
Wallasey	L. & C.	W. H. Travers.
Walmer	H.	H. W. Barker.
Walsall	M.	J. Taylor.
Walsall (Rural)	M.	W. P. Young.
Waltham Cross	E.	W. T. Streather.
Walthamstow	H.	E. Morley.

TOWN.	DISTRICT.	NAME.
Walthamstow	H.	G. W. Holmes.
Wandsworth (Eastern)	Met.	H. J. Marten.
" (Western)	Met.	P. Dodd.
Wanstead	H.	J. T. Bressey.
Wantage	H.	W. Hanson.
Ware	H.	H. F. Hill.
Warminster	West.	C. H. Lawton.
Warwickshire (County)	M.	J. Willmot.
Waterford	I.	M. J. Fleming.
" (County)	I.	W. E. L. Duffin.
Waterloo	L. & C.	F. S. Yates.
Watford	H.	D. Waterhouse.
Wath-upon-Dearne	Y.	H. C. Poole.
Wealdstone	H.	H. Walker.
Wellingborough	M.	E. Y. Harrison.
Wembley	H.	C. R. W. Chapman.
West Bromwich	M.	A. D. Greatorex.
West Hartlepool	N.	N. F. Dennis.
West Malling (Rural)	H.	J. Marshall.
Westminster	Met.	J. W. Bradl
Weymouth and Melcombe Regis	West.	W. B. Morgan.
Whitchurch	M.	M. Sowden.
Whitehaven	N.	E. E. Stiven.
Wicklow	I.	J. Pansing.
Widnes	L. & C.	J. S. Sinclair.
Willenhall	M.	T. E. Fellows.
Willesden	H.	O. C. Robson.
Wellington Quay	N.	J. F. Davidson.
Wilmslow	L. & C.	A. S. Cartwright.
Wilts (County)	West.	A. Dryland.
Wimbledon	H.	C. H. Cooper.
Winchester	H.	W. V. Anderson.
" (Rural)	H	G. E. Carter.
Windermere	L. & C.	C. E. Hines.
Windsor	H.	E. A. Stickland.
Winton	H.	J. H. Scott.
Wisbech	E.	K. J. S. Harris.
Wokingham	M.	C. W. Marks.
Wolverhampton	M.	G. Green.
Wombwell	Y.	J. W. Harrison.
Wood Green	H.	C. J. Gunyon.
Woodford	E.	W. Farrington.
Woolwich	Met.	J. R. Dixon.
Worcester	M.	T. Caink.
" (County)	M.	J. H. Garrett.
Worksop	M.	F. S. Whittell.
Worthing	H.	F. Roberts.
Wortley (Rural)	Y.	G. E. Beaumont.
Wrexham	W.N.	J. England.
" (Rural)	W.N.	J. P. Evans.
Yokohama, Japan	A.	R. Hara.
Yorkshire, East Riding	Y.	A. Beaumont.
" North Riding	Y.	W. G. Bryning.

ASSOCIATES.

* *Those Associates against whose names a star is placed have obtained the certificate of the Association.*

G *signifies elected as Graduate.*
TA *transferred to Associate.*

Date of Election and Transfer.		
1907 Jan. 19	ALDRIDGE, A. E. W.	Assistant Borough Surveyor Walsall.
1906 June 28	*ASH, H. J.	Chief Engineering Assistant, Council Offices, Nuneaton.
1901 Oct. 19	ASHBEE, W.	Divisional Surveyor, Middlesex C.C. Briarside, Hanwell, W.
1906 May 26	*BALLARD, W. E.	Assistant Engineer, Council Offices, King's Heath, near Birmingham.
1907 May 25	BAXTER, J. G. R.	Borough Engineer's Office, Great Grimsby.
1904 Sept. 17	BELL, C. D., B.Sc. (*Vict.*) ..	Borough Engineer's Office, Barrow-in-Furness.
G1897 July 31 TA1901 Oct. 19	*BENTLEY, J. H., A. M. Inst. C.E.	Deputy Borough Engineer, Town Hall, Oldham.
G1904 May 28 TA1905 June 22	*BERRIDGE, H. M. K., Assoc. M. Inst. C.E.	Assistant Surveyor, Council Offices, Long Eaton.
G1893 June 24 TA1902 Nov. 8	*BIRCH, J.	Deputy Surveyor, Public Offices, East Ham.
1903 Jan. 17	*BOOTH, E. W., A. M. Inst. C.E.	Engineering Assistant, Town Hall, Croydon.
G1905 Jan. 28 TA1907 Mar. 2	*BRADLEY, C. G.	Deputy Borough Surveyor, Leigh, Lancs.
G1899 June 10 TA1905 Jan. 28	*BRADSHAW, A. S.	Deputy Borough Engineer, Bedford.
G1898 June 30 TA1903 June 25	*BRISCOE, J. T.	Deputy Engineer, Council Offices, Enfield.
1903 July 25	*BROMLY, A., A.M. Inst. C.E.	Assistant Engineer, Town Hall, Croydon.
1902 Jan. 25	BROOKES, A. E.	Assistant County Surveyor, Worcester C.C. Breedon Cross, King's Norton, Birmingham.
1902 Jan. 25	BROWN, H. A.	Assistant Borough Surveyor, Town Hall, Fulham, S.W.
1904 May 28	*BURTON, W. E. H., Assoc. M. Inst. C.E.	Chief Engineering Assistant, County Architect's Office, Wakefield.
1904 Sept. 1	CARSON, W. H., Assoc. M. Inst. C.E.	City Engineer's Office, City Hall, Ottawa, Canada.
1904 May 28	CARTER, E. W. A...	Assistant City Surveyor, Guildhall, Gloucester.

Date of Election and Transfer.		
G1903 Dec. 12 / TA1907 Mar. 2	*Carter, S. F. R.	Assistant Engineer, Heston & Isleworth Urban District Council. Town Hall, Hounslow.
G1890 Sept. 13 / TA1902 Sept. 6	*Catchpole, H.	Deputy Engineer, Council Offices, Finchley.
G1904 May 28 / TA1907 May 25	*Cattlin, O., A.M.Inst.C.E.	Assistant Borough Surveyor, Municipal Offices, High Holborn.
G1895 May 25 / TA1902 May 10	*Clark, A. H. F.	District Engineer, P.W.D., Ceylon.
G1894 July 7 / TA1904 Sept. 17	*Claypoole, A. H., A.M. Inst. C.E.	District Surveyor, 63 Queen Square, Bristol.
G1898 Dec. 17 / TA1902 Mar. 22	*Clews, C. A.	Deputy Borough Surveyor, Derby.
G1899 June 29 / TA1902 Jan. 25	*Collinge, T. P., A.M. Inst. C.E.	Deputy City Engineer, Town Hall, Carlisle.
G1897 Feb. 13 / TA1901 Oct. 19	*Collis-Adamson, A. C.	Assistant Borough Engineer, Hornsey, N.
1904 Oct. 11	Connor, C.	c/o W. Kennedy, Ltd., 25 Victoria Street, Westminster.
1903 May 16	Cooke, J. E.	Assistant Borough Engineer, Town Hall, Islington.
G1900 May 19 / TA1901 Oct. 19	*Coombs, C. A.	Engineering Assistant, Town Hall, Burton-on-Trent.
1907 Sept. 7	Court, W. H. A., A. M. Inst. C.E.	Borough Surveyor's Office, Leicester.
G1899 Oct. 21 / TA1902 Nov. 8	*Cowan, G.	District Surveyor, Town Hall, Portsmouth.
G1901 Aug. 24 / TA1901 Oct. 19	*Cox, A. L., A.M.Inst.C.E.	City Surveyor's Office, Manchester.
1905 Mar. 4	*Cox, C. L.	Assistant Engineer, Municipal Offices, Colombo.
G1906 Jan. 20 / TA1907 Mar. 2	*Crabb, H. R., A.M.Inst.C.E.	District Surveyor, Council House, Birmingham.
1902 Jan. 25	Crook, W. E.	Chief Engineering Assistant, Middlesex C.C. Guildhall, Westminster.
G1905 June 22 / TA1906 Nov. 3	*Cross, W. G.	Assistant Borough Surveyor, Tunbridge Wells.
1901 Oct. 19	*Croxford, C. H.	Chief Engineering Assistant, Town Hall, Wood Green, N.
G1903 Dec. 12 / TA1905 May 27	*Debney, W., A.M. Inst. C.E.	Borough Engineer's Office, Birkenhead.
1904 Aug. 19	De Kretser, H. K.	District Engineer, P. W. D., Colombo, Ceylon.
G1891 Sept. 12 / TA1902 Sept. 6	*Dolamore, F. P.	Deputy Borough Engineer, Bournemouth.
1904 Aug. 12	Donald, R. B., A.M.Inst.C.E.	Resident Engineer's Office, Sewage Disposal Works, Huddersfield.
1906 June 28	*Dresden, W. J.	Chief Engineering Assistant, Town Hall, Battersea.

Date of Election and Transfer.		
1907 Jan. 19	*Dunning, W. J.	Assistant Surveyor, Council Offices, Colwyn Bay.
G1899 June 29 TA1905 June 22	*Dyer, R. H.	Assistant Borough Engineer, Southend-on-Sea.
G1898 Dec. 17 TA1901 Dec. 7	*Ellison, D., A.M.Inst.C.E.	Deputy Borough Engineer, West Bromwich.
G1898 Feb. 19 TA1902 Jan. 25	*Endsor, H. A.	Surveyor, Rural District Council, Keynsham, Bristol.
1904 Aug. 27	Forbes, W.	Burgh Engineer's Office, Edinburgh, N.B.
G1899 Oct. 21 TA1903 July 25	*Foster, H. H.	Assistant Surveyor, Borough Surveyor's Office, Wandsworth. 215 High Rd., Balham.
G1901 May 11 TA1902 Jan. 25	*Gair, J.	Assistant Borough Surveyor, Town Hall, Hammersmith, W.
P1903 Mar. 21	Galbraith, A. R., A.M.Inst. C.E.I.	District Surveyor, Town Hall, Portsmouth.
1905 June 22	*Gammage, E. J.	Borough Surveyor's Office, Dudley.
1905 June 22	*Goode, W. J.	Divisional Surveyor, Shropshire. Wellington, Salop.
G1899 Dec. 16 TA1902 May 10	*Goodfellow, H., A.M.Inst. C.E.	Chief Engineering Assistant, Town Hall, Southport.
1907 Apr. 27	*Gooseman, A. T.	Deputy Borough Engineer, Bootle.
G1894 Jan. 13 TA1902 July 10	*Gordon, J., A.M. Inst. C.E.	Assistant Burgh Surveyor, Aberdeen, N.B.
1903 July 25	Gray, A. R.	Engineering Assistant, Council House, Birmingham.
G1893 Jan. 14 TA1901 Oct. 19	*Greenwood, J. P., A.M. Inst. C.E.	Deputy Borough Surveyor, Town Hall, Burnley.
1904 Aug. 9	Greig, J. M. M., A.M.Inst. C.E.	c/o Messrs. Kennedy, Ltd., Partick, Glasgow.
1902 Mar. 22	Hadfield, W. J.	Deputy City Surveyor, Town Hall, Sheffield.
G1897 June 19 TA1901 Oct. 19	*Haigh, W. H., A.M. Inst.C.E.	Chief Engineering Assistant, Town Hall, Cardiff.
1903 June 6	Harding, H. W.	Chief Engineering Assistant, City Engineer's Office, Bristol.
G1899 Oct. 21 TA1902 May 10	*Harper, A.	Deputy Borough Surveyor Town Hall, St. Helen's, Lancs.
1907 Mar. 2	Harpur, S. J.	Assistant Engineer, Middlesex C.C., Guildhall, Westminster, S.W.
1906 Mar. 3	*Haskins, W. J.	Assist. Superintendant, P.W.D., Singapore, S.S.
1903 June 6	Heap, H., A. M. Inst. C.E.	16 Manor Avenue, Grimsby.
G1903 Jan. 17 TA1905 Apr. 29	*Heath, J. R.	Assistant Borough Surveyor, Burslem.

Date of Election and Transfer.		
1904 Aug. 26	Henderson, R. T.	City Engineer's Office, City Chambers, Glasgow, N.B.
G1905 Dec. 9 TA1906 Dec. 15	*Hewitt, F.	Borough Road Surveyor, Southport.
G1900 Mar. 10 TA1902 May 10	*Hinchsliff, E. R.	Deputy Surveyor, Council Offices, Barry.
1905 Jan. 28	Hipwood, J. W., A. M. Inst. C.E.	Chief Assistant, Borough Eng. Office, Southend-on-Sea.
G1900 Aug. 25 TA1902 Mar. 22	*Holloway, W. C.	Chief Engineering Assistant, Council Offices, Kettering.
G1897 July 31 TA1902 Nov. 8	*Jenkins, R. J.	Chief Assistant, Town Hall, Portsmouth.
G1897 June 19 TA1902 Jan. 25	*Johnston, R. W.	Deputy Borough Engineer, Town Hall, Birkenhead.
G1901 June 8 TA1904 Mar. 26	*Jones, H. O.	Assistant Borough Engineer, Folkestone.
1902 May 10	Ker, A. M., B. Sc. (*Vict.*), A.M. Inst. C.E.	Assistant Borough Engineer, Town Hall, Warrington.
G1896 June 25 TA1906 Dec. 15	*Kieser, W. H. G., Assoc. M. Inst. C.E.	District Surveyor, Bristol.
1906 Mar. 3	Kinnear, C. F. A...	City Chambers, Edinburgh.
1904 Feb. 27	Kirby, H. C.	Town Engineer's Department, Pretoria, S.A.
1901 Dec. 7	Lashmore, E. W., Assoc. M. Inst. C.E.	District Surveyor, Alma Vale Road, Clifton, Bristol.
G1903 June 25 TA1906 Dec. 15	*Lees, H. B.	District Eng., Jaffna, Ceylon.
1907 Sept. 7	Lilley, A. S.	Borough Engineer's Office, Margate.
G1901 May 11 TA1901 Oct. 19	*Lismer, A. B., A.M.Inst.C.E.	Assistant Engineer, Town Hall, Edmonton.
1904 Sept. 6	McInnes, D.	City Engineer's Office, Glasgow, N.B.
1902 Nov. 8	McKenzie, L. S., A.M.Inst.C.E.	District Surveyor, 63 Queen Square, Bristol.
G1896 Dec. 15 TA1907 Nov. 2	*Mackenzie, W. H.	Assistant Borough Engineer, Bournemouth.
1903 Mar. 21	Manning, W. R., A. M. Inst. C.E.	Assistant Borough Surveyor, Town Hall, Chelsea.
1904 Aug. 4	Marr, G. E.	District Offices, Hamilton, N.B.
G1905 Jan. 28 TA1907 June 20	*Mathew, H. B., A.M.Inst. C.E.	Chief Assistant, Borough Engineer's Office, Dover.
G1900 Apr. 21 TA1901 Dec. 7	*Miller, G. F.	Chief Assistant, Borough Engineer's Office, Hastings.
G1898 Dec. 17 TA1901 Oct. 19	*Mitchell, G.	25 Victoria Avenue, Newtownards, Co. Down, Ireland.
1904 Sept. 19	Morrison, A. W.	Burgh Engineer's Office, Edinburgh, N.B.
G1902 July 10 TA1907 Jan. 19	*Nathanielsz, A. H., Assoc. M. Inst.C.E.	District Engineer, P.W.D., Bungalow, Wegambo, Ceylon

Date of Election and Transfer.		
G1901 Aug. 24 TA1902 Nov. 8	*NEAVE, J.	Chief Assistant, Engineer's Department, Town Hall, Walthamstow.
G1906 Jan. 20 TA1907 Nov. 2	*NEWMAN, W. W.	Assistant Engineer, Urban District Council, Watford.
1904 Aug. 17	OLIVER, J. R...	Burgh Engineer's Department, Edinburgh, N.B.
G1895 June 27 TA1902 July 10	*OPENSHAW, J., A.M.Inst.C.E.	Engineering Assistant, Town Hall, Salford.
G1902 Mar. 22 TA1904 Oct. 29	*PARR, J. E., A.M.Inst.C.E. ..	Chief Assistant, Engineer's Office, Handsworth, Birmingham.
1904 Sept. 5	PATERSON, J. B.	Deputy Burgh Surveyor, Partick, N.B.
G1900 June 16 TA1902 Feb. 22	*PERCIVAL, W.	Assistant Borough Surveyor, Court House, Longton, Staffs.
1906 Jan. 20	*PERKINS, G. S.	Assistant Surveyor to the Urban District Council, Teddington.
G1895 Jan. 19 TA1901 Oct. 19	*PERKINS, J.	Engineering Assistant, Council House, Birmingham.
G1899 Oct. 21 TA1904 June 25	*PLANT, W., A. M. Inst. C.E.	Borough Engineer's Office, Leicester.
1903 Dec. 12	*RACE, A...	Chief Assistant, Borough Engineer's Office, Barrow-in-Furness.
1902 Mar. 22	RANSOM, W., A. M. Inst. C.E.	Chief Assistant Surveyor, Worcester. 81 Bath Road, Worcester.
1904 Aug. 31	REID, M...	Burgh Engineer's Office, Paisley, N.B.
G1899 Mar. 25 TA1907 Jan. 19	*RICHARDS, E. P.	Engineer's Office, Derwent Valley Water Board, Bamford, *viâ* Sheffield.
1904 Aug. 5	ROBERTSON, R.	Transvaal Irrigation Department, Pretoria, S.A., P.O. Box 557.
G1903 June 6 TA1904 Mar. 26	*ROSEVEARE, L., A.M.Inst.C.E.	Council House, Birmingham.
1902 Nov. 8	ROWBOTTOM, J.	Chief Assistant, Borough Surveyor's Office, Ashton-under-Lyne.
1903 June 6	SADLER, F.	Deputy Surveyor, Council Offices, Acton, W.
G1894 Oct. 20 TA1902 May 10	*SAVAGE, E. B., A.M.Inst. C.E.	Superintending Engineer, Sewers & Rivers Department, Council House, Birmingham.
G1899 Dec. 16 TA1901 Oct. 19	*SLATER, F. J.	Assistant Surveyor, Town Hall, Camberwell, S.E.
1904 May 28	*SMITH, C. P.	Assistant Borough Engineer, Town Hall, Greenwich.

Date of Election and Transfer.		
1906 Apr. 28	SMITH, H. J. T., A.M.Inst. C.E.	Assistant Engineer, Municipal Offices, Calcutta.
1901 Dec. 7	SPURR, F. W.	Chief Assistant, City Engineer's Office, York.
1904 Aug. 22	STEPHEN, T. M.	District Offices, Hamilton, N.B.
G1903 June 25 TA1904 Feb. 27	*STEVENS, H. L., A.M. Inst. C.E.	Buenos (New) Gas Co., Casilla 765. 1169 Calle Alsina, Buenos Ayres, S. America.
1904 Apr. 30	STORY, G. E.	Surveyor, Western District, Town Hall, Sheffield.
1903 Mar. 21	SUTCLIFFE, H.	Deputy Borough Engineer Town Hall, Huddersfield.
G1899 June 10 TA1905 Sep. 23	*THACKERAY, J. R...	Deputy Borough Surveyor, Eastbourne.
G1907 June 20 TA1907 Nov. 2	*THACKRAY, F. J.	Engineering Assistant, Rural District Council, Burnley.
1904 June 25	*THOMPSON, W., A.M.Inst.C.E.	Deputy Borough Engineer, Burton-on-Trent.
1905 Jan. 28	WALDRAM, R. E.	Assistant Borough Engineer, Town Hall, Woolwich.
G1904 May 28 TA1904 Dec. 3	*WALTON, J. S.	Borough Engineer's Office, Torquay.
1905 Sep. 23	WARD, A. W., A.M. Inst. C.E.	Assistant Borough Surveyor, Stockport.
1903 July 25	*WATMORE, JAS.	Assistant Surveyor, Council Offices, Aldershot.
G1899 June 10 TA1902 Mar. 22	*WEIR, J. S., A.M. Inst. C.E.	Borough Engineer, Jarrow.
G1902 July 10 TA1905 Jan. 28	*WHITAKER, G. H., A.M. Inst. C.E.	Chief Assistant, Borough Engineer's Office, Sunderland.
1903 May 16	WHITE, W. H. J., A. M. Inst. C.E.	Deputy Borough Engineer, Town Hall, Cheltenham.
G1902 Nov. 8 TA1904 Feb. 27	*WIBBERLEY, J., A.M.Inst.C.E.	Engineering Assistant, Municipal Offices, Plymouth.
G1901 Aug. 24 TA1907 Nov. 2	*WILKINSON, H. F., A.M.Inst. C.E.	Senior Engineering Assistant, Urban District Council, Tottenham.
1902 Mar. 22	WILLIAMS, H. B.	Chief Assistant, Borough Engineer's Office, Workington.
1902 July 10	WILLIAMS, J.	Assistant Borough Surveyor, Town Hall, Hampstead, N.W.
G1901 Dec. 7 TA1906 Dec. 15	*WILLIAMS, J. H.	Deputy Borough Engineer, Todmorden.
1906 Apr. 28	WILLIAMS, S. G., Assoc. M. Inst. C.E.	Assistant Engineer, Municipal Offices, Singapore, S.S.
G1898 June 30 TA1901 Dec. 7	*WILLIS, E., Assoc. M. Inst. C.E.	Surveyor U.D.C., Council Offices, Chiswick.
G1898 June 30 TA1901 Dec. 7	*WILSON, F., A.M. Inst. C.E.	District Surveyor, 63 Queen Square, Bristol.
G1891 Aug. 1 TA1901 Oct. 19	*YARWOOD, H.	Assistant Borough Surveyor, Town Hall, Rochdale.
G1901 June 8 TA1902 Feb. 22	*YELLAND, T.	Assistant Borough Engineer, Bury.

GRADUATES.

All Graduates hold the Certificate of the Association.

Date of Election.		
1906 April 28	ANDREWS, S. H.	28 Penhurst Road, South Hackney, N.E.
1893 Oct. 2	BALL, J. B., M. Inst. C.E. ..	Engineer's Office, G.C. Railway, Marylebone, N.W.
1905 June 22	BARKER, H. W.	Council House Handsworth, Birmingham.
1890 Mar. 29	BAYLEY, G. H., A.M.Inst.C.E.	19 Cooper Street, Manchester.
1897 July 31	BEARD, E. T., M. Inst. C.E...	4 The Crescent, Scarborough.
1906 June 28	BEAUMONT, R. H...	Greno Lodge, Grenoside, near Sheffield.
1906 Dec. 15	BELL, G. H.	37 Glanmor Crescent, Swansea.
1906 May 26	BENTLEY, W...	468 St. Helens Road, Bolton, Lancs.
1902 Mar. 22	BERRINGTON, E. E. W... ..	28 Victoria Street, Westminster, S.W.
1903 Dec. 12	BIKER, W. J. E.	Municipal Offices, Harrogate.
1900 June 16	BLAKEWAY-PHILLIPS, R. ..	City Engineer's Office, Westminster, S.W.
1901 Aug. 24	BLANCHARD, R.	Town Hall, Leicester.
1889 June 8	BLIZARD, J. H., A.M.Inst.C.E.	Lansdowne House, Southampton.
1892 Oct. 15	BRADSHAW, J. B., A.M.Inst. C.E.	Cotfield, Bensham, Gateshead-on-Tyne.
1896 June 25	BRUCE, W...	Burgh Engineer's Office, Edinburgh.
1905 May 27	BULL, E. M.	Council Offices, Finchley, N.
1899 June 29	BURGESS, R. W.	Town Hall, Stratford, E.
1903 June 6	BUTLER, H. L.	18 Gayton Road, Hampstead.
1905 June 22	BUTLER, R.	"Woodthorpe," Prospect Road, Tunbridge Wells.
1904 June 25	BUTT, E. E. W.	Council Offices, Birmingham.
1902 July 10	BUTTON, F. E.	City Surveyor's Office, Manchester.
1906 June 28	CAPLEN, L.	Rusthall, Tunbridge Wells.
1897 June 19	CARTLEDGE, J. R.	Assistant Surveyor, District Council Offices, Barnes, S.W.
1906 May 26	CASTLE, J. H...	27 Highbury Park, Highbury, N.
1906 Dec. 15	CATHCART, A. B., A.M.Inst. C.E.	c/o Water Engineer, St. Peter's Church Side, Nottingham.
1904 Dec. 3	CLARKE, R. E.	Public Offices, Arnold, Notts.
1894 July 7	CLEGG, H., A.M. Inst. C.E. ..	Surveyor to the Urban District Council, Felixstowe.
1903 Dec. 12	COCHRANE, J...	15 Ure Place, Montrose Street, Glasgow.
1906 May 26	CONWAY, F. J. K.	Borough Engineer's Office, Town Hall, Birkenhead.
1906 Dec. 15	COUZENS, R. H.	City Engineer's Office, Carlisle.
1904 May 28	COWLISHAW, H. H.	43 Lennard Road, Penge, S.E.
1904 Jan. 23	COX, C. E.	Windmill Hill, Cradley. Cradley Heath.
1897 June 19	CRESWELL, W. T.	11 Victoria Street, S.W.
1906 Sept. 22	CRISWELL, W.	Contractor's Office, Derwent Valley Waterworks, Bamford, Sheffield.
1892 July 11	CROSS, F. W., A.M. Inst. C.E.	"Ingleside," Clifton Road, Sutton Coldfield.

Date of Election.		
1907 May 25	Crossley, H. B.	Town Hall, Richmond, Surrey.
1907 May 25	Croxford, J. W.	Council Offices, Brentford.
1903 June 6	Cubitt, H. W.	County Hall, Spring Gardens, S.W.
1905 Jan. 28	Darby, A. E...	Town Hall, West Didsbury, Manchester.
1906 Jan. 20	Darby, H.	Town Hall, Ealing.
1901 June 8	Davidge, W. R., Assoc. M. Inst. C.E.	District Surveyor, Lewisham (West), 301A Brockley Road, S.E
1902 July 10	Dawkins, F.	Borough Surveyor's Office, Bournemouth.
1907 Nov. 2	de Colville, H. M.	Caxton House, Westminster, S.W.
1902 July 10	Deeley, G. P.	Moushall, Amblecote, Brierley Hill, Staffs.
1898 June 30	Dent, J. P.	1 Woodside Terrace, Nelson, Lancashire.
1904 May 28	Draper, J.	Council House, Handsworth, Birmingham.
1903 Oct. 17	Duncan, L. G.	10 Hanover Buildings, Southampton.
1906 May 26	Eayrs, T. W., A.M.Inst.C.E.	"Thornlea," Beeches Road, West Bromwich.
1907 Sept. 7	Edwards, E. W.	Municipal Buildings, Pontypridd.
1906 Dec. 15	Edwards, J. H.	9 Talbot Road, Wrexham.
1898 Dec. 17	Essex, E. H., A.M. Inst. C.E.	Town Hall, Leyton, N.E.
1905 May 27	Farrar, W.	Town Hall, Todmorden.
1886 Sept. 11	Fenton, W. C.	10 Paradise Square, Sheffield.
1900 June 16	Fisher, R.	37 Inman Road, Harlesden, N.W.
1903 July 25	Ford, J...	Lower House, Branscombe, Axminster.
1903 Feb. 21	Foster, J. W.	Town Hall, Bradford.
1903 June 6	Foster, W. A.	Town Hall, Accrington.
1903 June 25	Gettings, S. S., Assoc. M. Inst. C.E.	Resident Engineer's Office, Waterworks, Moreton-in-the-Marsh, Glos.
1899 June 10	Gibson, W. S.	"Everitta," Finchley Lane, N.W.
1888 July 12	Glass, S. N., A.M. Inst. C.E.	16 Ravenscroft Road, Chiswick.
1905 Jan. 28	Goddard, F. B.	41 High Street, Wandsworth.
1906 Dec. 15	Goldsmith, W. H.	Town Hall, Hull.
1906 May 26	Griffiths, H.	Borough Surveyor's Office, Crewe.
1898 Jan. 15	Grimley, F. C.	Sutton Bridge, Lincolnshire.
1904 Dec. 3	Grove, A.	1 Parkfield Terrace, Stourbridge.
1905 June 22	Gunson, E., A.M. Inst. C.E.	c/o Grindlay & Co.. Calcutta.
1905 June 22	Hadfield, J. R.	District Council Offices, Barnes.
1904 Jan. 23	Harkness, J.	20 Duke Street, Edinburgh.
1901 June 27	Harlow, W. W. B., Assoc. M. Inst. C.E.	City Engineer's Office, Carlisle.
1906 Mar. 3	Harrison, J.	355 Manchester Road, Burnley.
1903 June 25	Harrison, P. T.	Town Hall, Fulham.
1907 Nov. 2	Harrison, W. A.	Edgerton House, Winewall, near Colne, Manchester.
1905 Oct. 28	Hassall, J.	Resident Engineer's Office, Western Valleys (Mon.) Sewerage Board, Bassaleg, Mon.

Date of Election.		
1904 May 28	Hatton, J.	1 Mill Cliff, Buxton, Derbyshire.
1907 Mar. 2	Hazeltine, C. A...	10 Summerhill Road, South Tottenham.
1893 Jan. 14	Hellawell, O.	Town Hall, Withington, Manchester.
1906 June 28	Hewes, G. W.	27 Williams Road, Burnley.
1906 Dec. 15	Hewitt, A. C.	"Nutfield," Scarborough Road, Filey, Yorkshire.
1896 June 25	Hills, O. C.	360 Mare Street, Hackney, N.E.
1900 June 16	Hobson, E.	117 Oakland Road, Hillsborough, Sheffield.
1907 Mar. 2	Hodge, A. C...	15 Wiseton Road, Brocco Bank, Sheffield.
1906 Mar. 3	Holden, R. B.	Town Hall, Oldham.
1888 July 12	Houghton, J.	King's Heath, Birmingham.
1904 Oct. 29	Howell, H. H.	63 Queen Square, Bristol.
1903 Jan. 17	Howells, D. P., A.M.Inst. C.E.	Town Hall, Wynberg, S.A.
1907 May 25	Hoyle, J. A...	Borough Surveyor's Office, Haslingden.
1907 Jan. 19	Hunt, C. F.	Brooke Cottage, Leigh-on-Sea, Essex.
1899 June 10	Hutchings, W. A...	Springfield Brewery, Wolverhampton.
1904 Dec. 3	Hutchinson, H. F.	Engineer's Dept., Town Hall, Walthamstow.
1903 Dec. 12	Jacques, H. S.	5 Radnor Road, Westbury-on-Trym.
1906 Dec. 15	Jenkinson, F. C.	29b High Street, Rotherham.
1905 Jan. 28	Jennings, W...	Borough Engineer's Office, Leyton.
1907 May 25	Johnson, W. H.	Town Hall, Great Yarmouth.
1907 Sept. 7	Jones, F. E.	Lisbourne Farm, Lisbourne Lane, Stockport.
1903 July 25	Jones, T., A.M.Inst.C.E. ..	53 Princes Street, Southport.
1906 Dec. 15	Jones, T.	Townfield Road, West Kirby.
1906 May 26	King, J. S.	Council Offices, Friern Barnet, New Southgate, N.
1903 June 25	Knight, R. R.	Council Offices, Bromley, Kent.
1903 June 25	Knowles, G. P., A.M. Inst. C.E.	39 Victoria Street, S.W.
1907 Sept. 7	Laird, N. P...	Thurnby, near Leicester.
1905 Dec. 9	Lake, W. S., A.M.Inst.C.E.	Borough Engineer's Office, Plymouth.
1906 Dec. 15	Lees, R. B.	99 Antrobus Street, Congleton, Cheshire.
1904 June 25	Lewis, H. M.	Town Hall, Staines.
1904 Dec. 3	Line, H. W.	L.C.C., 19 Charing Cross Road, S.W.
1907 May 25	Loach, A. E...	Council House, Aston Manor, Birmingham.
1906 June 28	Ludford, E. W.	Belle Vue House, Ravenscourt Square, Hammersmith.
1905 Sep. 23	Lyddon, A. J.	Engineer's Office, 23 Valentine Road, King's Heath, near Birmingham.

Date of Election.		
1905 May 27	McArd, A. J.	Edge Hill, Whitehaven.
1900 Dec. 15	MacDonald, K. G.	13 Charles Street, St. James's, S.W.
1905 May 27	Maitland, W. H...	Town Hall, Hoylake, Cheshire.
1903 June 25	Mann, E. E.	Borough Engineer's Office, Southampton.
1904 May 28	Mansfield, F.	Town Hall, Hereford.
1903 Jan. 17	Marrian, H. G., Assoc. M. Inst. C.E.	Bank Chambers, Twickenham.
1906 April 28	Marsh, F. E.	Municipal Engineer's Office, Singapore, S.S.
1894 Jan. 13	Martin, E. B., A.M.Inst.C.E.	Borough Engineer, Rotherham.
1903 Jan. 17	Masters, W. H.	Glencairn, Arthur Road, Southampton.
1906 Dec. 15	Matthews, R. H...	178 High Road, South Tottenham, N.
1905 May 27	Matthew, S...	South Villa, Crow Nest Park, Dewsbury.
1900 June 16	Mattinson, H., A.M.Inst.C.E.	55 Piccadilly, Manchester.
1904 May 28	Millar, P.	Borough Engineer's Office, Southampton.
1906 May 26	Milner, J. D., A.M.Inst.C.E.	City Engineer's Office, Hull.
1901 Oct. 19	Milnes, B.	Town Hall, Birkenhead.
1905 May 27	Minors, E.	City Engineer's Office, Worcester.
1905 June 22	Morgan, G. L.	11 The Parade, Pontypridd.
1899 June 10	Moss, P. A.	153 Highbury Hill, Highbury, N.
1902 Jan. 25	Moss, W.	14 Hesketh Avenue, Didsbury, Manchester.
1904 Dec. 3	Needham, J. E.	Municipal Engineer's Office, Shanghai.
1906 Jan. 20	Newsome, S. H.	City Surveyor's Office, Sheffield.
1904 May 28	Nicholls, R.	Borough Engineer's Office, Southampton.
1896 June 25	Nightingale, C. F.	"Endellion," Buchanan Road, Walsall.
1905 Sep. 23	Nighy, J.	"Highcliffe," Fulwich Road, Dartford.
1907 June 20	Ollevant, H. E.	"Norwood," Nelson Street, Rotherham.
p1905 Jan. 28	Owen, J., A.M.Inst.C.E. ..	Engineer's Department, L.C.C., Spring Gardens, S.W.
1901 Aug. 24	Oxberry, F. W.	Borough Engineer, Kendal.
1899 Oct. 21	Palmer, G. F.	"Oaklands," North Ormesby, Middlesbrough.
1901 Feb. 6	Palmer, W. L. F., Assoc. M. Inst. C.E.	City Engineer's Office, Bristol.
1906 Dec. 15	Parker, E.	Stretford District Council Offices, Old Trafford, Manchester.
1904 May 28	Parker, J.	9 Winchester Rd., Ilford, Essex.
1906 June 28	Parsons, A. S.	Borough Surveyor's Office, Aston Manor, Birmingham.
1906 Dec. 15	Peacock, J. L.	Sewage Works Contract, Mayfield. Sussex
1906 June 28	Pearce, W. H.	Borough Engineer's Office, Southend-on-Sea.

Date of Election.		
1904 June 25	Pearson, T. G.	Town Hall, Barrow-in-Furness
1896 Feb. 22	Perkins, T. L., A.M. Inst.C.E.	P. W. D., Hong Kong.
1903 Feb. 21	Perrott, E. S.	6 Elliston Road, Redland, Bristol.
1903 Dec. 12	Persey, W. C.	Town Hall, Barrow-in-Furness.
1902 July 10	Phillips, R.	41 Okehampton Road, Willesden, N.W.
1901 Aug. 24	Pickin, W. H.	L.C.C. Works Department, Belvedere Road, Lambeth, S.E.
1904 May 28	Piercy, M. A.	The Grove, Eagle Road, Wembley, Middlesex.
1907 May 25	Pimm, G. B. R.	98 St. Andrew's Road, Exmouth.
1906 Dec. 15	Pool, H...	10 Jasper Street, Hanley, Staffs.
1907 Mar. 2	Poulden, G. E .L.	c/o A. Scott, Esq., Santiago, Chili, S. America.
1888 Sept. 15	Pritchard, T., M. Inst. C.E.	264 Gresham House, Old Broad Street, E.C.
1898 June 30	Quick, A. H., Assoc. M. Inst. C.E.	"Inverness," Malvern Road, Thornton Heath.
1904 Dec. 3	Quirk, J. J.	Borough Surveyor's Office, Swindon, Wilts.
1900 Dec. 15	Rawstron, C. O.	Surveyor's Office, Rural District Council, Lichfield, Staffs.
1901 June 8	Read, F., Assoc. M. Inst. C.E.	Public Offices, Pentre, Rhondda, Glam.
1902 Nov. 8	Redford, W. T.	Town Hall, Eccles, Lancs.
1904 May 28	Richmond, W. S.	Municipal Offices, Highgate, N.
1900 Feb. 10	Ross, D.	Brynmenyn, near Aberkenfig, Glam., South Wales.
1900 June 16	Rousell, A. J., A.M.Inst.C.E.	Borough Engineer's Office, Worthing, Sussex.
1905 June 22	Sagar, J. H.	Council Offices, High Street, Poplar.
1906 May 26	Sawdon, J. S...	Municipal Buildings, Cheltenham.
1904 May 28	Schlund, W. T. S.	"Dulce Domum," Cleanthus Road, Shooter's Hill, S.E.
1902 July 10	Shepherd, G. G.	Town Hall, Ilford.
1906 June 28	Sherwood, A. F.	Borough Surveyor's Office, Town Hall, Hammersmith.
1899 June 29	Simms, F.	Town Hall, Sheffield.
1905 May 27	Sissons, F. P.	Assistant Borough Engineer, Hanley.
1905 Oct. 28	Slater, E. A., A.M. Inst. C.E.	201 Malden Road, Colchester.
1906 June 28	Small, L. J.	Surveyor's Department, Hendon R.D.C., Great Stanmore, Middlesex.
1906 Jan. 20	Smith, A.	North Road House, Fareham, Hants.
1898 Jan. 15	Smith, G. H.	1 Worcester Road, Wimbledon, S.W.
1906 May 26	Smith, W. B.	Public Offices, Hampton, Middlesex.
1905 Mar. 4	Snape, A. E., M.Sc., A.M.Inst. C.E.	102 Queen's Road, Norwich.
1898 June 30	Spink, J.	City Surveyor's Office, Manchester.
1899 June 29	Stanton, F. W. S., A.M. Inst. C.E.	28 Baldwin Street, Bristol.

Date of Election.		
1907 June 20	Stanyer, F.	Parkhurst, Cape Road, Warwick.
1904 June 25	Stephenson, W. E., A.M.Inst. C.E.	City Engineer's Office, Leeds.
1906 Mar. 3	Sutcliffe, H.	158 Todmorden Road, Burnley.
1904 May 28	Sutherland, D. S.	Hebe Cottage, Thynne Street, West Bromwich.
1906 June 28	Tasman, H. E.	Town Hall, Islington, N.
1900 Dec. 15	Taylor, H. T.	3 North Terrace, Gt. Meols, Hoylake, Cheshire.
1902 July 10	Taylor, S.	Town Hall, Manchester.
1907 Sept. 7	Thomas, E.	3 River Street, Todmorden.
1907 Sept. 7	Tomey, N. G.	86 Trinity Road, Handsworth, Birmingham.
1902 July 10	Tomlinson, J. W., A.M. Inst. C.E.	St. Mary's Hall, Coventry.
1905 Sep. 23	Tonge, J. A.	125 Nottingham Road, Mansfield.
1900 June 16	Tremelling, H., Assoc. M. Inst. C.E.	Borough Engineer's Office, Newport, Mon.
1903 Jan. 17	Tresseder, F. H.	The Nurseries, Cardiff.
1904 May 28	Tulley, G. W.	95 Slateford Road, Edinburgh.
1906 Sept. 22	Turton, C.	Penkridge, near Stafford.
1905 Dec. 9	Underhill, G. B.	St. Stephen's, Canterbury, Kent.
1904 May 28	Varey, J. A.	Westhill House, Chapel Allerton, Leeds.
1905 May 27	Vernon, A.	Town Hall, Upper Street, Islington.
1906 June 28	Wainwright, H. C.	22 Haden Hill, Wolverhampton.
1888 Jan. 14	Ward, F. D., A. M. Inst. C.E.	16 Hackins Hey, Liverpool.
1897 June 19	Webb, F.	Town Hall, Chelsea.
1898 Jan. 15	Wells, F. B., Assoc. M. Inst. C.E.	c/o The Great Southern Railway Co., Buenos Aires.
1902 Sept. 6	West, A. S., A.M.Inst.C.E...	Borough Engineer's Office, Harrogate.
1902 Jan. 25	White, C. D...	Council Offices, Hanwell.
1901 June 8	Whiteford, E. H., A.M. Inst. C.E.	Engineer's Office, Derwent Valley Water Board, Bamford, near Sheffield.
1902 July 10	Wilkinson, F., A.M.Inst.C.E.	Borough Engineer's Office, Wimbledon, S.W.
1901 June 27	Willett, A. J.	18 Castledine Road, Anerley, S.E.
1895 June 27	Williams, D. S.	Waterworks Office, Commercial Road, Portsmouth.
1900 Dec. 15	Wills, A. J.	3959 Penngrove Street, Philadelphia, U.S.A.
1900 July 19	Wrack, W. P.	117 High Street, Poplar, E.
1904 June 25	Wright, F. W.	Resident Engineer's Office, Sewerage Works, Camberley, Surrey.
1906 May 26	Wright, W.	14 Ventnor Road, Portland, Dorset.
1906 June 28	Wrigley, G. E.	Sandal Terrace, Sowerby Bridge.

STANDING COMMITTEES.

GENERAL PURPOSES COMMITTEE.

THE PRESIDENT (*ex-officio*).
J. PATTEN BARBER (ISLINGTON), *Chairman*.

W. N. BLAIR (St. Pancras).
J. A. BRODIE (Liverpool).
J. W. COCKRILL (Great Yarmouth).
A. E. COLLINS (Norwich).
C. H. COOPER (Wimbledon).
A. FIDLER (Northampton).
A. D. GREATOREX (West Bromwich).
W. HARPUR (Cardiff).
T. W. A. HAYWARD (Battersea).
CHAS. JONES (Ealing).
R. J. THOMAS (Bucks Co.).
H. T. WAKELAM (Middlesex Co.).
C. F. WIKE (Sheffield).
T. H. YABBICOM (Bristol).

FINANCE COMMITTEE.

THE PRESIDENT (*ex-officio*).
T. H. YABBICOM (BRISTOL), *Chairman*.

J. A. BRODIE (Liverpool).
A. E. COLLINS (Norwich).
W. HARPUR (Cardiff).
T. W. A. HAYWARD (Battersea).
CHAS. JONES (Ealing).
W. F. LOVEDAY (Stoke Newington).
P. H. PALMER (Hastings).
R. READ (Gloucester).
R. J. THOMAS (Bucks Co.).

PARLIAMENTARY COMMITTEE.

THE PRESIDENT (*ex-officio*).
J. S. PICKERING (CHELTENHAM), *Chairman*.

J. A. BRODIE (Liverpool).
A. E. COLLINS (Norwich).
A. T. DAVIS (Shropshire County).
J. DEWHIRST (Chelmsford Rural).
A. FIDLER (Northampton).
A. D. GREATOREX (West Bromwich).
F. MASSIE (Wakefield Rural).
P. H. PALMER (Hastings).
W. E. C. THOMAS (Neath Rural).
C. F. WIKE (Sheffield).

PAPER COMMITTEE.

THE PRESIDENT (*ex-officio*).
H. T. WAKELAM (MIDDLESEX Co.), *Chairman*.

J. PATTEN BARBER (Islington).
J. W. COCKRILL (Great Yarmouth).
C. H. COOPER (Wimbledon).
A. D. GREATOREX (West Bromwich).
T. W. A. HAYWARD (Battersea).
W. F. LOVEDAY (Stoke Newington).
J. S. PICKERING (Cheltenham).
R. READ (Gloucester).
R. J. THOMAS (Bucks Co.).

THE

INCORPORATED ASSOCIATION OF MUNICIPAL AND COUNTY ENGINEERS.

THIRTY-FOURTH ANNUAL MEETING.

LIVERPOOL, *June* 20, 21, *and* 22, 1907.

THE Members assembled in the Council Chamber of the Town Hall, where Mr. Alderman Smith, the Deputy-Mayor, in the absence of the Lord Mayor, offered a most hearty welcome to the Association.

The President, Mr. J. Patten Barber, on behalf of the Association, returned thanks for the kind welcome offered them.

The Secretary read the Minutes of the last Annual General Meeting, which were confirmed and signed.

The Secretary read the Council's Annual Report.

ANNUAL REPORT.

The Council have pleasure in presenting their Annual Report.

DISTRICT MEETINGS.

Since the last Annual General Meeting, seven District Meetings have been held. At Trowbridge, July 21, 1906; Windsor, September 29; Westminster, November 16; Slough and Burnham, May 11, 1907; Belfast, May 17 and 18; Colwyn Bay, May 31 and June 1; and St. Andrews, June 15.

THE ROLL OF THE ASSOCIATION.

During the financial year ending April 30 last, 68 new Members, consisting of 15 ordinary Members, 11 Associates,

and 42 Graduates, have joined the Association. Six Members have resigned, ten names have been written off or not re-elected, and the Council record with regret the deaths of J. Carline, T. L. Edwards, T. W. Franks, G. Hodson, J. N. Horsfield, F. J. C. May (Past-President), H. U. McKie, R. H. Middleton, and J. Smith.

The numbers on the roll of the Association at the close of the year were 9 honorary Members, 850 ordinary Members, 144 Associates, and 204 Graduates—making a total of 1207.

TABLE SHOWING NUMERICAL INCREASE.

—	1901 to 1902.	1902 to 1903.	1903 to 1904.	1904 to 1905.	1905 to 1906.	1906 to 1907.
Hon. Members	9	8	10	10	10	9
Members	823	810	813	852	844	850
Associates	58	83	93	123	138	144
Graduates	129	133	144	158	180	204
Total	1019	1034	1060	1143	1172	1207

The Council have transferred 10 Associates and 5 Graduates to the class of Members, and 8 Graduates to the class of Associates, these gentlemen occupying positions qualifying them under the Bye-laws for transfer.

THE FINANCES.

The audited Balance-Sheet and Statement of Revenue and Expenditure, which accompanies this Report, shows an excess of Income over Expenditure, for the year ending April 30 last, of 25*l.* 19*s.* 9*d.*

The general question of the Finances will be found to be dealt with later on in this Report.

EXAMINATIONS.

Since the last Report, five examinations have been held. Ninety-five candidates have been examined, of whom 45 satisfied the Examiners, and have been granted the Testamur of the Association. A further reference to this subject also will be found later on in this Report.

Premiums.

The Council have awarded the Association premium of 10*l.* to Mr. T. R. Smith, of Kettering, for his papers read at the District Meeting at Kettering, September 1905, and a premium of 3*l.* to Mr. J. Young, of Ayr, for his paper read at the District Meeting at Ayr in August 1905.

The New Council.

The Scrutineers, having examined the ballot lists, report the following members elected as the Council for the year 1907–8:

President.—Mr. J. A. Brodie.

Vice-Presidents.—Messrs. W. N. Blair, E. P. Hooley, and C. F. Wike.

Ordinary Members of Council.—Messrs. C. H. Cooper, H. A. Cutler, A. Fidler, A. D. Greatorex, W. Harpur, T. W. A. Hayward, P. H. Palmer, J. Paton, J. S. Pickering, W. H. Prescott, R. Read, H. E. Stilgoe, R. J. Thomas, H. T. Wakelam, and A. E. White.

Hon. Secretary.—Mr. Charles Jones.

Hon. Treasurer.—Mr. Lewis Angell.

The Past-Presidents (ex-officio Members of Council) are Messrs. A. T. Davis, A. E. Collins, and J. Patten Barber. The elective Past-Presidents are Messrs. O. C. Robson, T. H. Yabbicom, and J. Lobley.

Payment of Expenses.

The Joint Committee, to which reference was made in the last Annual Report, have continued their labours towards obtaining an amendment of the Conferences Act to enable Local Authorities to pay the reasonable expenses of duly appointed officials, besides the Clerk, incurred in attending meetings at which matters relating to their duties are discussed.

A deputation to the Local Government Board was asked for and refused, and the Board will neither depart from their present practice of surcharging Authorities who pay such expenses, nor offer any hope of the promotion of legislation to amend the Act.

Under these circumstances the Committee will apparently have to await a favourable opportunity to procure, by the tedious and expensive process of private legislation, the removal

of a restriction which is obviously unfair and opposed to the best interests of municipal government.

Payment of Permanent Staff out of Loans.

The President of the Local Government Board was good enough to receive a deputation from your Council in connection with this matter. Cases were carefully prepared, showing the difficulties and extra cost to the ratepayers arising from the regulation of the Board, *i.e.* that no permanent official or workman should be paid out of loans granted by the Board.

Mr. Burns said that the statements laid before him were concerning large cities and towns, but that the Board were quite aware that irregularities existed in small places throughout the country, and it was to meet these cases that the regulation of the Board was made. He was most anxious to encourage in every way the employment of direct labour by Local Authorities, but viewed with disfavour the transfer of workmen usually employed on works of maintenance to new works, for which the Board were asked to sanction the payment by loans. Mr. Burns further said that he disapproved of the inclusion in loans of any portion of the salary paid to an officer, including a permanent foreman, but he would consider the suggestion of the deputation that the wages of "leading hands" from the permanent staff might be included.

Alterations in Articles and Byelaws.—Creation of a New Class of Membership.—Finance Generally.

Your Council feel that, in view of the importance of the proposals now placed before you, a brief retrospect of the growth and work of the Association will not be out of place.

Growth.

The growth of the Association is shown in the following table in quinquennial periods to the present day :—

Period.	(4 years) 1873-77.	1882.	1887.	1892.	1897.	1902.	1907.
Members..	175	210	274	454	703	823	850
Associates	—	—	—	—	—	58	144
Graduates	—	—	5	39	77	129	204
Total	175	210	279	493	780	1010	1198

Work.

Educational.—The year 1886 saw the commencement of what may be called the chief educational portion of the work of the Association, as in this year the first examination was held. Since that date 58 examinations have been conducted and 1263 candidates have been examined. Of these 642 succeeded in satisfying the examiners and duly received the Testamur of the Association.

The following table shows the growth quinquennially in the number of candidates examined:—

Period.	(2 years) 1886, 1887.	1892.	1897.	1902.	1907.
Candidates examined ..	70	116	198	388	491

The figures themselves demonstrate sufficiently the constantly increasing value placed by candidates upon the possession of the Testamur, whilst Local Authorities throughout the Kingdom are recognising that this is an examination, covering completely the scope of the work of the Municipal and County Engineer, carried out by engineers themselves either past or present Municipal Officials, in a most thorough and practical manner.

In particular the recognition by the Local Government Board of Ireland of the certificate as a sufficient qualification for the post of Deputy County Surveyor is most gratifying.

Much more, however, may be done by members of the Association in this direction, by bringing the examinations under the notice of their assistants and pointing out to them the necessity of obtaining this evidence of their qualifications, and further in appointing assistants by giving preference (other things being equal) to applicants who hold this certificate.

General.

The general work of the Association has largely broadened in recent years. The advancement of the status of the Municipal and County Engineer has received continuous and earnest attention. The persistent efforts which have been made in the past are slowly but surely bearing fruit, and to-day the recognition of the fact that Municipal Engineering demands the

same general knowledge and the same amount of technical training as the various other branches of the engineering profession, is rapidly spreading. It is, therefore, not too much to hope that in the not very distant future this recognition will result in a much more liberal appreciation of the loyal and devoted services rendered by Municipal Engineers generally, than has been the case in the past.

FINANCES.

The question of the Finances of the Association has been, for some years past, receiving the careful attention of the Finance Committee appointed by your Council. On their recommendation, the Council appointed a special Committee, consisting of the members of the Finance Committee, together with the Chairmen of all other Committees, and they have now reported to your Council that the income of the Association, administered with the utmost possible economy, is inadequate for the necessary expenditure, unless the work of the Association is to be very largely curtailed.

To do this, the Council feel, would be disastrous to the Association and the advancement of the Municipal Engineering profession generally, and they therefore ask the careful attention of members to the means proposed for increasing the revenue of the Association to an extent which will enable them to go forward with the great work for which the Association of Municipal and County Engineers primarily exists, *i.e.* "the promotion of the science and practice of engineering applied to the health and improvement of counties, towns, and rural districts; the promotion of the professional interests, rights, powers, and privileges of County, Urban, and Rural Engineers, the improvement of their professional status, and the extension and interchange of professional knowledge and practice."

NEW CLASS OF ASSOCIATE MEMBERS.

For some time past the difficulty has been experienced that applications are received from gentlemen holding positions of too great importance to justify them in applying for election as Associate, and hardly important enough to warrant their election to full membership. To meet this difficulty, your Council propose the formation of a new class, to be called

Associate Members, who shall pay an Entrance Fee of £1 11*s*. 6*d*. (except otherwise exempted by holding the Testamur of the Association), and an Annual Subscription of £1 11*s*. 6*d*. Voting power is proposed to be extended to this class.*

SUBSCRIPTIONS.

The Council further propose that the subscriptions of Members shall be increased from £1 1*s*. to £2 2*s*., of Associates from 15*s*. to £1 1*s*., and of Graduates from 10*s*. 6*d*. to 15*s*.

Formal proposals are before you for the necessary alterations in the Articles and Byelaws to carry these suggestions into effect, and the Council earnestly hope that they may meet with your approval.

BYELAW 5A.

Your Council have added a clause to Byelaw 5A, which they trust will meet the objections raised at the last Annual Meeting as to the danger of its application to Members who have already been re-elected.

ARCHITECT'S REGISTRATION BILL.

This Bill provides that a Local Authority must employ a registered architect for such work as the preparation and examination of plans of buildings, the examination and reporting on existing or proposed buildings, and similar work now carried out by the surveyor and his staff. This clause is therefore intended to deprive Local Authorities of the advice and assistance of their officials in most matters connected with buildings and building plans, and would increase the expenses of administration and introduce complications without any corresponding advantage.

The Parliamentary Committee had an interview with representatives from the Society of Architects, the promoters of the Bill, who agreed to submit an amended clause to satisfy the wishes of the Council, and the matter is still under consideration.

A circular letter was sent to the Clerks of all Local Authorities, calling attention to this Bill, and also to the Public Health Acts (Building Byelaws) Bill.

Both these Bills are for the present withdrawn.

* *For amounts finally adopted, see discussion on this Report.*

Model Building Byelaws.

Your Council are pleased to report that the Local Government Board consented to receive a deputation to discuss with them the Report submitted to the Council on Building Byelaws and the Board's Model Building Byelaws. The deputation had a long interview with the permanent officials of the Board of a highly satisfactory nature.

National Housing Reform Council.

A special Committee have met representatives from the National Housing Reform Council and discussed with them the question of planning new areas, model building byelaws, and the erection of houses in Urban and Rural Districts.

The Parliamentary Committee have had under consideration, and are still engaged in watching, the progress of various Bills that are receiving the attention of both Houses of Parliament.

Delegates to Other Bodies.

The following gentlemen are serving as delegates from your Association to other bodies :—

Mr. Chas. Jones	to the	Sanitary Inspectors' Examination Board (London).
„ W. Nisbet Blair	to the	N.A.L.G.O.
„ C. F. Wike	„	„
„ J. S. Pickering	„	National Housing Reform Council Exhibition.
„ H. T. Wakelam	„	Roads Improvement Association and National Dustless Roads Committee.
„ T. W. A. Hayward	„	Plumbers' Registration Committee.
„ A. E. Collins	„	Joint Committee on Reinforced Concrete.
„ J. W. Cockrill	„	„ „

Mr. J. W. Cockrill and Mr. E. J. Lovegrove were appointed to represent your Association at the Conference of the R.I.B.A.

Notification of Meetings to Local Authorities.

The Council have carefully considered this matter, and as a preliminary step to a general invitation to Local Authorities to appoint delegates to the Association meetings, have issued invitations to the various Local Authorities in the districts of Lancashire and Cheshire, Yorkshire, Midlands, and North Wales, represented in this Association, to appoint two delegates to a Conference to be held in connection with the 1907 Annual Meeting. It is confidently hoped that the Conference which has been arranged will prove of the utmost interest and utility.

Legal Protection to Members.

Your Council carefully investigated a case laid before them, but to their regret were compelled to advise the member that, whilst it was undoubtedly a hard case, and one in which the Local Authority ought in common fairness to meet his claim, yet the terms of his appointment prevented any likelihood of his being successful in an action at law.

Identification Badges.

Representations having been made to the Council as to the desirability of the provision of a scheme for mutual recognition at meetings, badges corresponding with a number given in a printed list have been issued to all attending this meeting. The Council trust this will prove a convenience to members and visitors.

Signing Applications.

The Council desire to call the attention of the Association to the desirability of Members refraining from signing applications for admission to the Association unless they are *personally acquainted* with the applicants and their work.

Conclusion.

In conclusion, it is the pleasing duty of your Council to again place on record the high appreciation due to the members of the various Committees who have given their services and time ungrudgingly to the work of the Association.

Charles Jones, *Hon. Sec.*
Thomas Cole, *Secretary.*

On the motion of the President, seconded by Mr. A. T. Davis, the Report was received and adopted subject to discussion on clauses relating to increase in subscriptions, etc.

Mr. John A. Brodie moved, Mr. C. Brownridge seconded, the alterations in the Byelaws as printed and circulated.

The following amendment was proposed by Mr. Mawbey, seconded by Mr. C. Chambers Smith, and carried by a large majority: "That the subscriptions in future be, for Members, £1 11*s.* 6*d.*; for Associate Members, £1 5*s.*; for Associates, £1 1*s.*; and for Graduates, 15*s.* That the entrance fees in future be for New Members, Associate Members, and Associates the same amount as the subscriptions."

The following amendment was proposed by Mr. Eayrs, seconded by Mr. Edge, and carried: "That the word 'Associate' in line 1, Byelaw 5A, be not deleted."

The following amendment was proposed by Mr. H. C. Marks, duly seconded and carried: "In Byelaw 11, 'two' should be altered to 'five.'"

The altered Byelaws were then adopted as amended. (*ante.*)

The Meeting was then made special, and certain alterations in, and additions to, the Articles of Association were proposed and carried. (*ante.*)

(In accordance with the Companies Acts the alterations and additions to the Articles of Association were confirmed at a Special Meeting duly convened, and held at the Westminster Palace Hotel, Victoria Street, London, on July 6, 1907.)

The General Meeting having been resumed, the Association's premiums were presented: £10 in books to Mr. T. R. Smith, of Kettering, for his paper read at the District Meeting, at Kettering, September, 1905; and £3 in books to Mr. J. Young, of Ayr, for his paper read at the District Meeting, at Ayr, in August, 1905.

Mr. H. F. Peet, of Bloemfontein, was elected Hon. Secretary for the African District, Mr. W. F. Loveday, of Stoke Newington, for the Metropolitan District, and the other District Secretaries were re-elected pending meetings in their various districts.

Mr. R. A. MacBrair and Mr. S. Stallard were re-elected Auditors for the ensuing year.

Messrs. R. J. Angel, A. H. Campbell, A. Gladwell, F. Harris,

W. F. Loveday, H. Shaw, C. C. Smith, and O. E. Winter were re-elected Scrutineers for the ensuing year.

Mr. J. Patten Barber then introduced his successor, Mr. John A. Brodie, and vacated the chair in his favour.

Mr. Mawbey proposed a hearty vote of thanks to the retiring President for his services to the Association during the past year. This was seconded by Mr. Wakelam, and carried with acclamation.

Mr. Barber acknowledged the vote.

The Conference* arranged between the Association and delegates from the various local Authorities referred to in the Council's Annual Report, was then formally opened by the Deputy Lord Mayor of Liverpool.

Mr. Brodie then read his Inaugural Address;* a hearty vote of thanks for which was proposed by Mr. W. Harper, seconded by Mr. Greatorex, and carried.

The following papers were read and discussed: "Liverpool," by E. R. Pickmere; "The defects of Sewer Ventilation Problems," by I. Shone; "Tramway Wear and Maintenance," by C. F. Wike; "Points from Building Laws of American Cities," by E. R. Matthews; "Calculation of Storm Water Discharge and Design of Sewerage Details," by E. E. W. Butt.

A cordial vote of thanks was accorded to the Lord Mayor and Corporation of Liverpool for the use of the Council Chamber for the purposes of the Meeting.

* The papers read at the Conference together with this address and the papers read and discussed at the Annual Meeting will be found at the end of this volume.

Dr. STATEMENT OF RECEIPTS AND EXPENDITURE

RECEIPTS.	£	s.	d.
To Balance, May 1, 1906	32	5	11
„ Entrance Fees of Members and Associates	18	18	0
„ Subscriptions	890	17	0
„ Subscriptions in advance	24	4	6
„ Arrears	66	1	6
„ Sale of "Proceedings"	22	16	4
„ Examination Fees	351	15	0
„ Interest on Investments	46	8	11
£	1453	7	2

Dr. STATEMENT OF ASSETS

LIABILITIES.	£	s.	d.
To Sundry Printing	50	0	0
„ Sundry Creditors	140	0	0
„ Subscriptions in advance	24	4	6
„ Balance	1173	14	9
£	1387	19	3

Examined with the vouchers and

EXPENDITURE.	£ s. d.	£ s. d.
By Balance of Petty Cash from last account	..	1 12 3
„ Reports of Meetings	..	63 0 0
„ Examiners' Fees and Expenses	..	92 15 0
„ Messrs. Clowes for Vol. XXXII.	285 2 0	505 18 3
„ „ „ General Printing and Postages ..	220 16 3	
„ Auditors' Expenses	..	2 12 6
„ Meetings, Expenses	..	32 16 9
„ Stationery	..	11 5 2
„ Illustrations for Volume	..	49 1 6
„ Rent of Office and Coals	..	78 13 8
„ Bankers' Charges	..	12 3
„ Furniture and Sundries	..	11 13 0
„ Rent of Telephone	..	8 10 0
„ N.A.L.G.O. Subscription and Expenses	..	5 19 0
„ Premiums	..	12 17 2
„ Parliamentary Papers and Times Law Reports ..	..	5 10 0
„ Secretary's Salary	..	300 0 0
„ Assistant Secretary's Salary	..	150 16 8
„ Petty Cash—		
Postages	32 4 5	
General	22 15 1	
		54 19 6
„ Balance of Petty Cash in hands of Secretary	..	3 8 3
„ Expenses of Byelaws Committee	..	8 1 6
„ Balance	..	53 5 2
	£	1453 7 2

AND LIABILITIES. Cr.

ASSETS.	£ s. d.	£ s. d.
By Balance at Bank, May, 1907	..	53 5 2
„ £290 Southampton Corporation 3½ % Stock at 100..	..	290 0 0
„ £553 12*s.* 9*d.* India 2½ % Stock at 76	..	420 0 0
„ £261 14*s.* 7*d.* London County Council 2½ % Consols at 73	..	191 0 0
„ £200 Metropolitan 2½ % Consolidated Stock at 74½	..	149 0 0
„ Loan to San. Insp. Joint Exam. Board	..	15 0 0
„ Subscriptions in Arrear	199 4 0	
Less 50 % bad	99 12 0	
		99 12 0
„ "Proceedings" in Stock	308 5 7	
Less 75 %	231 3 9	
		77 1 10
„ Office Furniture	..	89 12 0
„ Balance of Petty Cash in hands of Secretary	..	3 8 3
	£	1387 19 3

found correct, *May* 13, 1907.

SIDNEY STALLARD, R. A. MACBRAIR } *Auditors.*

LEWIS ANGELL, *Hon. Treasurer.*
CHARLES JONES, *Hon. Secretary.*
THOMAS COLE, *Secretary.*

WESTERN COUNTIES DISTRICT MEETING.

July 21, 1906.

Held in the Town Hall, Trowbridge.

J. PATTEN BARBER, M.INST.C.E., PRESIDENT, *in the chair.*

THE Chairman of the Urban District Council, Mr. H. Mundy, received the Members, and offered them a hearty welcome to Trowbridge.

The President, on behalf of the Association, thanked the Chairman for the kind welcome he had given them.

Mr. J. S. Pickering was unanimously re-elected Honorary Secretary for the Western Counties District.

MUNICIPAL WORK IN TROWBRIDGE.

BY H. G. NICHOLSON-LAILEY, M.INST.C.E.I.;
ENGINEER AND SURVEYOR
TO THE TROWBRIDGE URBAN DISTRICT COUNCIL.

HISTORICAL.

TROWBRIDGE is a market and manufacturing town situated on the Great Western Railway ninety-five miles west of London, and twelve south-east of Bath.

The historical past of this town is a very long and honoured one. In the twelfth century it was called Trobrege and Trowbrig, and after that Trolbrige, and then Thorough Bridge, and at the end of the sixteenth century True Bridge.

In A.D. 1100 the Manor of Trobrege is recorded as being in the possession of Edward of Salisbury, a famous Norman noble and sheriff of Wiltshire, and at his death it became the property of his daughter Matilda, whose husband was Humphrey de Bohun II. This Humphrey de Bohun built a famous Norman castle here called Troubrege Castle. This castle was besieged by King Stephen in the year 1139, during the struggle between Stephen and Matilda. The castle, now completely vanished, is recorded to have been in ruins in the sixteenth century, but a very small portion of the ruins are said to have been visible at the commencement of the nineteenth century.

The manor, after many possessors, descended to John of Gaunt, Duke of Lancaster, and eventually to his son Henry of Bolingbroke, afterwards King Henry IV.; it then became a part of the Duchy of Lancaster, and was merged in the Crown property. In 1536 King Henry VIII. granted the manor to Edward Seymour, Duke of Somerset, and in 1750 it passed from the Seymour family to the Duke of Rutland. Thomas Timbrell, Esq., purchased the manor in 1809, and the present Lord of the Manor is W. Stancomb, Esq., of Potterne, Wiltshire.

Trowbridge has for several centuries been famous for the manufacture of West of England cloth, and was a flourishing centre of the cloth trade in the fifteenth century. This manufacture is still the principal source of employment and gain for the inhabitants of the town, and cloth with the Trowbridge stamp upon it has always found ready buyers and good prices in the marts of the world.

General Statistics.

The town was formerly governed by a Local Board of Health, which was formed in June 1865, but under the Local Government Act, 1894, it is now controlled by an urban district council consisting of twenty-one members.

The area of the district is 2126 acres, and the population at the census of 1901 was 11,526.

The net assessable value is as follows:—

	£	s.	d.
Trowbridge	35,313	10	0
Hilperton and Clarendon	1,927	6	3
Total	£37,240	16	3

A rate of 1*d.* in the £ produces £155 3*s.* 5*d.*

The council's indebtedness up to March 31, 1906, was £52,730 11*s.* 11*d.*, and the general district rate for the year ending March 31, 1907, is 3*s.* 8*d.*, in the £ for Trowbridge and 3*s.* 4*d.* in the £ for Hilperton and Clarendon.

Vital Statistics.

The birth rate for the year 1905 was 21·7 per thousand of the population, and the average for the past ten years 20·7 per thousand.

The death rates for the same periods are 12·5 and 13·4 per thousand of the population.

The following table shows the number of cases of infectious disease notified during 1905 compared with the figures of 1904, and the average of the past ten years.

	1905.	1904.	1905–1904.
Diphtheria	17	12	8·4
Membranous group	—	—	·5
Erysipelas	7	5	11·8
Scarlet fever	92	40	31·5
Enteric fever	1	5	3·5
Puerperal fever	—	—	·9

Markets.

The Trowbridge markets were formerly held in the public streets of the town until 1871, when William Stancomb, Esq., the then Lord of the Manor, erected at his own expense the present market house and adjoining cattle market.

In the year 1891, the local board purchased from Mr. Stancomb the whole of these premises, including all manorial rights in connection therewith, for the sum of 6000*l.*, and has since spent considerable sums in improving and enlarging same.

The regular markets for the sale of cattle and dead stock are held every alternate Tuesday, and the vegetable and fish market is held every Saturday.

Municipal and other Buildings.

The Town Hall, which was a gift to the town by the late Sir W. Roger Brown, is built in the English Renaissance style of

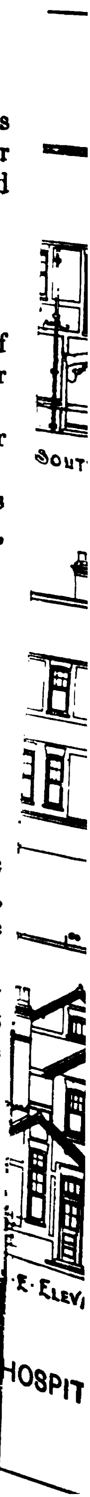
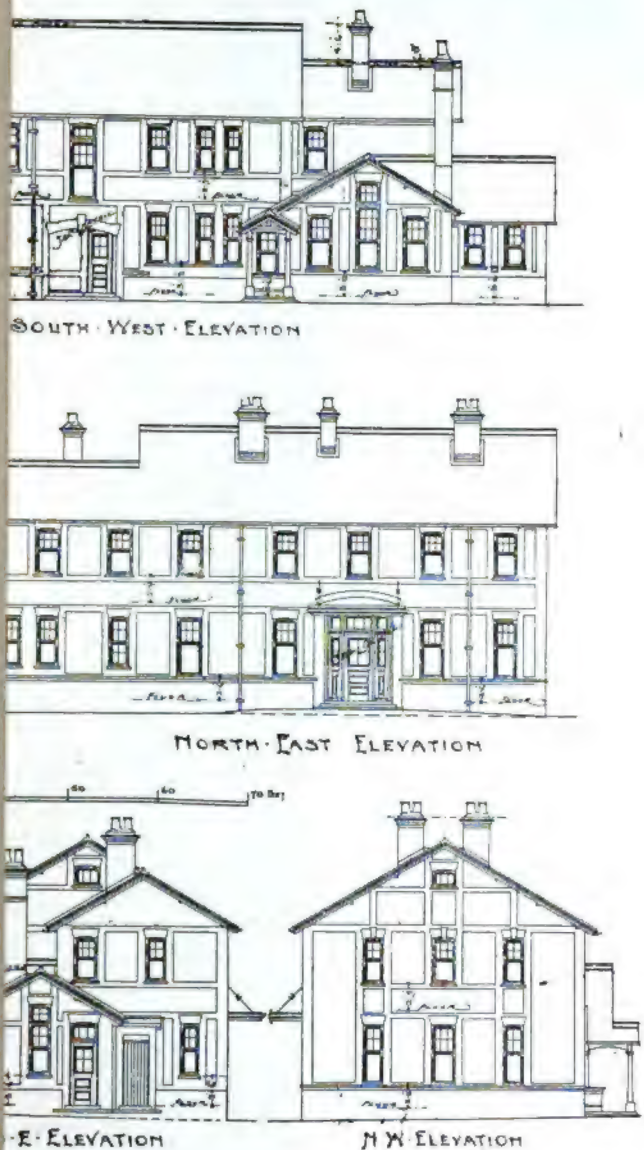


PLATE No. I.



HOSPITAL:

To face p. 16.

architecture apparently of the Jacobean period. The exterior is built of Atworth stone with Corsham stone dressings. The interior contains a large public hall, council chamber and other rooms on the first floor, and on the ground floor sessions court, barrister's, registrar's and committee rooms; also a complete suite of offices for the urban district council's officials.

The building was erected at a total cost, including furnishing, of £28,000, and completed and formally opened by H.R.H. the Duchess of Albany in June 1889.

The Victoria Technical Institute was erected at a cost of 7800*l.*, in memory of her late Majesty's 1897 Jubilee.

Isolation Hospital.

A temporary isolation hospital was erected upon a site purchased by the Urban District Council in 1889, and has served the town until quite recently, when its place has been taken by a new and complete set of buildings erected and governed by a Joint Hospital Board.

This joint board was formed in 1900, and consists of twenty-one members representing the Urban District Councils of Trowbridge, Bradford-on-Avon, Westbury, and Melksham; also the Rural District Councils of Bradford-on-Avon, Westbury, and Melksham, including a population of 40,000.

This board purchased a site of 4 acres in 1902 within the Trowbridge Urban District, and competitive designs were invited for erecting the buildings.

The contract for carrying out the work was let in July 1903, and the buildings were completed and formally opened on November 14, 1905.

The hospital provides accommodation for thirty patients, and comprises five buildings, namely:—

Administrative block, three ward pavilions, and a block containing the laundry, disinfector chamber, ambulance house, mortuary, etc. The administrative block is two stories in height, but the other buildings are all of one story only. The buildings are carefully planned and arranged on the site with regard to aspect, approach, communication with and between the various blocks and isolation of same, provision being made for all probable future extension.

Administrative Block.—This block, which is placed in the

south-east corner of the site, commands the entrance gates, as well as the roads and footpaths to the various buildings, the pavilions being to the north of it, and the laundry and other buildings to the rear or west of it. The administrative block is arranged on the corridor plan, and contains dispensary, two sitting rooms, for the matron and nurses, eight bedrooms, changing room, bath room, lavatories, stores, complete kitchen offices, etc. An external serving lobby is provided for serving out food for the pavilions, and in addition to the principal entrance separate entrances are provided for the doctor and nurses, and for trade purposes.

The Ward Pavilions.—The provision for patients in the several pavilions is as follows:—

Pavilion No. 1:	Two large wards of eight beds each	16
	Two private wards of one bed each	2
" No. 2:	Two wards of four beds each	8
" No. 3:	Two wards of two beds each	4
	Total number of beds	30

The allowance of space in respect of each bed is as follows: 12 ft. linear wall space, 156 ft. super. of floor space, 2028 cubic ft. of air space; all the wards are 13 ft. high; every bed has a window on each side of it.

The Laundry.—This contains receiving lobby, wash-house, drying closet, ironing room, etc.

The Disinfector.—This is of oval shape sufficiently large to disinfect a full size mattress; it is placed in two chambers adjoining the laundry, the infected articles being placed in the disinfector from the infected chamber on the one side, and taken out in the disinfected chamber on the other side.

The Mortuary and Ambulance House adjoin the laundry; the former is placed quite out of view from all the wards, and is provided with an external viewing chamber, with glass panel in the top of it fitted with copper frame and cover.

The total cost of the whole scheme was:—

	£
Land	500
Buildings	8063
Furniture	650
Architect's fee, Quantity Surveyor, etc.	670
	£9883

Practically 330*l.* per bed.

Roads.

At the present time there are nearly 8 miles of main roads, and a little over 8 miles of district roads in the town which are repaired by the authority.

The whole of the main roads are macadamised, the portions having most wear, and also where steep gradients occur, are coated with 2-in. broken Clee Hill stone. Other portions are coated with 2½-in. broken Mill Grit stone. Some portions in the town have also been coated with tarred limestone. The latter material, where laid, considerably lessens the noise of traffic on the roads and largely prevents dust, but the Author finds that it wears somewhat unevenly, probably due to the difficulty of keeping the traffic off same before it has properly set.

The district roads are metalled with 2½-in. broken Somerset limestone, obtained from Frome and Shepton Mallet.

The Wilts county council pay the whole cost of the maintenance of the main roads together with annual sums of 88*l.* for salaries and establishment charges, 27*l.* for scavenging, 69*l.* for watering, and in cases of permanent improvements the whole cost in the first instance is borne by the district council either by loan or from current expenditure, and repaid by the county council in ten equal yearly instalments without interest.

The annual contributions of the county council for road maintenance have considerably varied during the past four years, owing to the fact that in carrying out the drainage scheme most of the main roads were very much mutilated, both by laying the sewers and the house connections. The county authorities refused to pay anything for maintenance of the roads thus affected, except in cases where small portions urgently required patching, the cost of such work being remitted to the district council upon the production of all vouchers showing the actual payments.

The total cost paid by the county council for roads and footpath maintenance for the year ending March 31, 1906, was £2676, and the estimated amount required to be paid by them for the present year is £2726.

Footpaths.

Various materials have been used for paving the footpaths throughout the town, viz.:—

Concrete *in situ*, concrete paving slabs, pennant stone paving slabs, and tar paving. In most cases where concrete *in situ* pavements are laid the curb is formed in the pavement itself, in the case of other pavements pennant stone kerb of various sizes is used.

A considerable amount of new paving has lately been laid under the Author's supervision in many main roads and other footpaths, most of the work being done by contract as follows:—

Concrete *in situ* pavement, including kerb of the same material, and consisting of 2 in. of ¾-in. limestone chippings and cement gauged three to one and topped with ½-in. layer of ¼-in. Leicestershire granite chippings and cement gauged two to one, all laid on a 4-in. broken stone foundation. Average cost, 4*s.* 6*d.* per super. yard.

Pennant stone flagging 2½ in. thick laid and jointed on a bed of fine engine ashes or sand. Average cost, 7*s.* 6*d.* per super. yard exclusive of kerbing, which varies in price according to size.

A very large quantity of the old pennant stone paving, which has been taken up in various streets, where new paving has been laid, has been found to be of sufficient thickness to stand re-dressing. This work has been done at a cost of 2*s.* 6*d.* per super. yard, and when finished makes an excellent material for new pavements; in fact the Author finds it in many respects superior to new flags.

Tar paving is mostly manufactured and laid by the council's own workmen. The stone used is Somerset limestone ¾-in. to 1-in. gauge for the bottom layer, and ¼-in. gauge, carefully screened, for the top layer. The stone is heated in a kiln until all moisture is evaporated, and then thoroughly mixed with boiling tar with a small admixture of pitch. The cost when laid averages 2*s.* 6*d.* per super. yard. This makes a cheap and durable pavement for by-streets and district road footpaths.

PRIVATE STREET WORKS.

The Private Street Works Act of 1892 has been adopted by the council, and several streets made up in the following manner:—

Carriageway.—12-in. hard core foundation, well rolled, and

6 in. of hand-broken limestone in two layers of 2½-in. and 2-in. gauge respectively, well rolled and blinded in with fine limestone chippings.

Footways.—12 in. by 4 in. pennant stone kerb and 2½ in. of tar paving. The channels are also formed with tar paving 3 in. thick and 15 in. wide. All crossings are paved with pennant stone crossing, laid on a concrete foundation and grouted in pitch and tar.

The surface water gullies used are "Sykes" patent street gullies.

The cost per foot frontage, excluding surface draining, averages 10*s.*

Public Lighting.

The street lighting is at present done by 320 incandescent gas lamps. These lamps are the property of the local gas company who do the whole of the cleaning, repairs, lighting and extinguishing for the sum of 2*l.* 17*s.* 6*d.* per single burner lamp per annum.

An electric lighting order was obtained in 1901, but the council did not proceed to carry out the work in view of the large expenditure ahead of them with their sewerage and sewage disposal scheme. The order has since been taken over by the Western Electric Distributing Corporation, Limited, and by an agreement with that company, the council have been recouped a portion of their expenses in connection with the order, viz.: 350*l.*, and retain a right to purchase the undertaking in 7, 14, 21, 28 or 35 years from June 30, 1905, upon giving the company 12 months' notice of their intention so to do.

Water Supply.

The water supply is in the hands of a company, who obtained their first Act of Parliament in 1873. The supply is obtained from a chalk formation and also from the lower greensand at Upton Scudamore, a point seven miles south of Trowbridge. The water is pumped into reservoirs in the parish of Dilton and thence flows by gravitation to Trowbridge.

Sewerage.

A scheme of main drainage was carried out in this town in 1872, the system discharging directly into the river Biss.

A new main drainage scheme has recently been carried out by the Author, at a cost of over £20,000, which includes in addition to several miles of new main and subsidiary sewers the reconstruction of a large portion of the system laid down in 1872.

The works were divided into three sections and let in three separate contracts as follows:—

Section No. 1.—This section comprised the re-sewering of an insanitary area known as the water works district, and consisted of taking up several lengths of old brick sewers varying from 1 to 2 ft. in diameter, and substituting 9 in. stoneware pipe sewers, laid on a bed of lias lime concrete, also several lengths of new sewers connecting new building estates to the existing system.

The whole of the existing system throughout the town was ventilated by the erection of forty ventilating shafts 26 ft. high and 6 in. internal diameter.

Storm-water overflow chambers were also constructed at convenient points discharging into the river to relieve the sewers in flood time. The overflow weirs in these chambers are fixed so as to come into operation when the flow of sewage exceeds six times the normal dry-weather flow. In addition 200 "Sykes" patent street gullies were fixed throughout the town replacing old stone untrapped sinks, this being a very urgently needed improvement owing to the sewerage system being combined.

The work of re-sewering the water works district was somewhat of an unpleasant character, the old sewers, most of which had little or no fall whatever, were found to be nearly full of black sludge (the accumulation of many years) and considerable difficulty was experienced in removing same, the sewers being laid in narrow back ways between continuous rows of small cottages. The house connections were also a pitiable sight, the usual method being found to consist of two separate lengths of pipes to each small cottage, never less than 12 in. diameter, and often 18 in. in diameter, connecting one yard gully and one w.c. to the sewer, the connection at the sewer being made by knocking a few bricks in or out of the sewer (on the top of the barrel for preference) and finished off with a substantial amount of clay puddle. This state of affairs rendered it a difficult and somewhat costly matter to temporarily connect these properties up to the junctions on the new sewers, the property owners being in the

meantime (in some cases perhaps more forcibly than politely) required to redrain their premises in a proper manner.

Section No. 2.—This section consisted of the reconstruction of the main intercepting sewer, which is laid in the valley of the river Biss through the town and conveys about three-fourths of the town sewage to the outfall. This sewer was constructed in 1872 and consisted of about 2000 yds. of egg-shaped and brick barrel sewer varying in size from 4 ft. by 2 ft. 6 in., to 4 ft. 6 in. circular, emptying directly into the river at a point about 40 yds. south-west of the new outfall works. It was constructed with soft brickwork jointed in lime mortar, and had become in a very dilapidated condition, chiefly owing to the jointing material having perished, and the brickwork in many places decaying and crumbling away. This state of affairs naturally caused a tremendous amount of surface water to leak into the sewer throughout its whole length, and it became absolutely necessary to entirely reconstruct the sewer.

It was first proposed to lay a new pipe sewer with double seal joints half encased in concrete in and through the old sewer, which scheme was submitted to the Local Government Board and disapproved as being impracticable; that body, however, eventually approved a scheme for laying a portion of the new sewer in an entirely new line, and a portion in the line of the existing old sewer providing the same was cut through, destroyed, and properly filled in. The contract for the work was let in August 1903, viz.: laying a 21 in., 18 in., 15 in., and 12 in. stoneware and cast-iron pipe sewer about 2000 yds. in length. In laying the outfall or lower length of this sewer a very large amount of rock and water was met with, considerably increasing the expense of the work, and the council upon the advice of the Author decided to lay the remaining portion (1200 yards) through the old existing sewer, in the following manner: the pipes were entirely surrounded with cement concrete gauged 8 to 1 which was faced to a smooth surface on the top, and the old sewer preserved intact as far as possible in order that it could be utilised as a storm-water outfall, should it be necessary at any time to adopt a separate system in the town. Where a manhole was built on this length, a by-pass was constructed consisting of 15-in. pipes and beds surrounded in concrete on either side of the manhole in each case.

Section No. 3.—This section comprised the largest portion of

the "Northern Sewerage system," and the construction of 142 manholes upon the existing town system.

The "Northern Sewerage" included the laying of 4½ miles of new 9-in. and 12-in. sewers, together with 72 manholes, 10 flushing chambers, and 14 ventilating shafts, in the unsewered and added portions of the district: most of this work was of a straightforward character, the excavation being chiefly in Oxford Clay and a considerable amount of rock. The system is connected to the outfall works by a 12-in. outfall sewer, partly laid in tunnel and entirely surrounded with 9 in. of cement concrete gauged 8 to 1. The lower portion, which is laid through water-logged ground is constructed with double seal pipes and in bad places surrounded with concrete.

The construction of the manholes upon the existing system throughout the town, was insisted upon by the Local Government Board, who required that a chamber should be built wherever a change of direction, or a junction, occurred upon the system. This has been an excellent improvement, as we are now able to properly flush and inspect the sewers periodically. The cost of building these manholes in many cases exceeded the estimate, as it was often found, when the ground was opened, considerable repairs were required to various lengths of sewers as well as building the manholes, it also led in many instances to the invaluable discovery of leakages of subsoil water into the sewers.

The costs of the different sections were as follows:—

Section No. 1, £3427 2*s.* 5*d.* Section No. 2, £4311 11*s.* 10*d.* Section No. 3, £12,500 2*s.* 3*d.* Total cost, £20,238 16*s.* 6*d.*

The whole of the work has been entirely carried out under the Author's supervision with the aid of two clerks of works. It must also be mentioned that Mr. W. H. Allen, Assistant Town Surveyor, rendered valuable assistance both in the preparation and carrying out of the scheme.

The work was commenced in January 1903, and completed (with the exception of coupling up to the outfall works) at Christmas 1905. The Author, upon the council's instructions, then took over the duties of Resident Engineer for the completion of the sewage outfall works, a full description of which is given in the paper submitted by Mr. W. H. Stanley.

A DESCRIPTION OF THE SEWAGE DISPOSAL WORKS, TROWBRIDGE, WILTS.

By W. H. STANLEY, A.M.Inst.C.E.

The Urban District of Trowbridge comprises an area of 2126 acres with a population in 1901 of 11,526. The town is situated on a small stream known as the Biss, which discharges into the river Avon one mile below the Town Bridge. The subsoil is Oxford clay.

The water supply is in the hands of a company, the daily consumption averaging 19·5 gallons per head.

Manufactures.

The woollen industry, including wool scouring and dyeing, is the staple trade of the town, its West of England cloth having for two or three centuries enjoyed a world-wide reputation. There are also large breweries and several bacon-curing establishments, where large numbers of pigs are slaughtered. At present a considerable amount of trade effluent discharges into the sewers, but the bulk of that from the woollen mills goes into the river. There is no separate system of drainage, and this fact, together with the trade effluents that will have to be dealt with, necessitates much larger disposal works than the mere size of the town would at first indicate.

The town was sewered in 1875, the main outfall sewer discharging into the Biss half a mile below the railway station, but the construction of the disposal works then proposed was left in abeyance. Pressure from various quarters, together with an injunction obtained by a neighbouring landowner, made the question of the pollution of the stream a pressing matter, and in 1900 the Author was instructed by the urban council to prepare a scheme for dealing with the sewage. There being no suitable land for irrigation he recommended that the works

should be on bacterial lines, and Mr. Dibdin was called in by the council to advise and report, especially as to the probable action of the chemicals used in the woollen trade, on the proposed process of purification. His report was favourable. Meanwhile the Author made investigations as to the quantities of trade effluents then discharging into the public sewers and stream, and the following are extracts from his report thereon laid before the council in 1901.

Cloth Manufactories and Dye Works.

As the staple trade of the town, the cloth factories and dye works naturally account for by far the largest bulk of the liquid trade refuse affecting the river, and it will be seen by the figures hereinafter given what an enormous amount it is. Practically speaking, the whole of this water is pumped from the river, and with three exceptions is after use returned thereto, and used over and over again by the various mills lower down the stream.

The water thus pumped up and returned to the river is used for the following purposes:—(1) Wool scouring; (2) Wool rinsing; (3) Piece washing; (4) Dyeing.

1. *Wool Scouring.*—The water for this process is, with three exceptions, where the wool is washed in the stream, used through machines. The wool after being scoured with hot water, soap and soda, is rinsed by a continuous flow of cold water. The first treatment results in a very foul effluent heavily charged with grease and alkali; as the process proceeds the water naturally becomes less polluted, but still contains a considerable amount of grease, etc.

2. *Wool Rinsing.*—The effluent resulting from this process is of a better character than the foregoing.

3. *Piece Washing.*—The machines used for this purpose take a large quantity of water, which is heavily fouled, especially at the beginning of the process, with grease, etc. In several of the factories the first washings are conveyed to the Innox Oil Mill, where the grease is abstracted and utilised as an article of commerce.

4. *Dyeing.*—The effluents discharged from the dye vessels, the Author need hardly say, are much discoloured, and contain chemical matter in various degrees of solution.

OTHER TRADES.

Innox Oil Mill.—Here a portion of the scouring water from the wool-scouring and piece-washing machines in several factories is treated, the effluent, impregnated with sulphuric acid, being discharged into the river.

Breweries.—The water used here is mostly obtained from the water company by meter, and thus can be more readily gauged. Besides its conversion into beer, it is used for cooling, malt steeping, and cask-washing purposes. The whole of the liquid waste from the two breweries discharges into the main sewers; in the other a portion goes into the main sewer, and the remainder is discharged through an old drain into the river.

Maltings.—At present, the liquid waste from one malthouse appears to discharge into the main sewer, and that from the other into the river.

Gas Works.—There is occasionally a small discharge from these works into the river, amounting to about 2000 gallons a day, consisting of water polluted with carbonates and traces of ammonia.

Slaughter Houses.—The whole of the drainage from these premises already discharges into the main sewers.

Liquid Trade Refuse.—The following figures are the estimated quantities of liquid trade refuse discharged from the cloth factories and dye works per diem, assuming that all the mills, including the one now closed, are working to the full extent of their present machinery, and that the wool scouring, where at present carried on in the river, is done in machines.

	Gallons.
Wool scouring	140,000
Wool rinsing	756,000
Piece washing	274,000
Dyeing	62,000
Total	1,232,000

Of this quantity the estimated amount discharged into the new sewers is 137,805 gallons per day, leaving a net total of 1,094,195 gallons discharged into the river.

Innox Oil Works.—The estimated amount of liquid waste is 40,000 gallons per day.

Breweries and Maltings.—The amount of liquid waste refuse at present reaching the river is estimated to be 9000 gallons per

day. This is exclusive of water used for cooling purposes, which will continue to discharge into the river.

Gas Works.—Occasionally an estimated quantity of 2000 gallons per day reaches the river.

Liquid Trade Refuse at present Discharged into the River.

Summary.

	Gallons per Day.
From cloth factory and dye works	1,094,195
Innox oil works	40,000
Breweries and maltings	9,000
Total	1,143,195
Gas works (only occasionally)	2,000
Estimated quantity of liquid trade refuse, included in the above total of 1,143,195 gallons per day, which reaches the river through old drains	240,650
Estimated quantity of clear water discharged into the new sewers that should be returned to river	80,000

Recommendations.—As a preliminary to the taking in of additional liquid trade refuse into the sewers, the Author recommended: (1) That the council adopt some such rules as are in operation at Leeds; (2) That the liquid trade refuse from the breweries, maltings, and Innox oil works be taken into the sewers; (3) That all waste dye water be taken into the sewers, if so required by the manufacturers.

Capacity of Works.

The works are designed to provide for the treatment of 240,000 gallons of sewage per day, multiplied by three, equal to 720,000 gallons, and, in addition, 280,000 gallons of trade effluent, making a total of 1,000,000 gallons to be treated as sewage, and the storm water bed has a capacity for dealing with 720,000 gallons of storm water.

The whole of the above has to be pumped. 280,000 gallons per day for trade effluent is an assumed quantity, and considering a larger amount may have to be dealt with, the Author kept the sedimentation tank higher above the contact beds than usual, to allow of converting one or more into sprinkling filters should it be found necessary hereafter.

Description of Works.

Pumping Station.—This stands on 2 acres of land close to the river Biss, approached from the Bradford Road by a new road carried over the river by three small bridges constructed of steel trough decking, the spans being 12 ft., 16 ft., and 18 ft.

The 21-inch outfall sewer discharges into a screening chamber, provided with a ½-inch screen having a revolving rake working in same.

There are two detritus tanks, from which the sewage is pumped, each 54 ft. by 14 ft. 6 in., having a joint capacity of 100,000 gallons. Over these tanks are the engine room, 40 ft. by 33 ft., and gas producer house, 33 ft. by 15 ft. The tanks are constructed of cement covered by 21 in. brick arches, carrying the floor of engine house, with two sumps for cleaning the tanks.

The concrete is composed of Portland cement, Holt sand, and crushed Mendip limestone in the proportion of 1:2:3. Cattybrook bricks are used throughout for brick walling with blue vitrified brick copings.

Machinery.—The gas engines consist of three 18½ B.H.P. for sewage, one 10 B.H.P. for storm-water, and a 1½ B.H.P. for working the air compressor.

The pumps are three 5 in. and one 6 in. centrifugal. One of the sewage pumps is a stand-by for storm-water.

The producer gas plant, suction type, is in duplicate with a total capacity of 60 B.H.P.

A 3-in. main is also laid on from the town gas supply for lighting and as a general stand-by.

The contract requires each 18½ B.H.P. engine to raise 30,000 gallons per hour through a 12-in. rising main, 312 yards in length with a lift of 48 ft., and the 10 B.H.P. 40,000 gallons per hour through a rising main 12 yards in length with a lift of 22 ft.

Storm-water Bed.—This adjoins the engine house, having an area of 1375 super. yards, constructed of concrete with a clay puddle bottom 12 in. in thickness, depth 4 ft., filled in with coarse local clinker.

Upper Site (13 *acres*): *Rising Main and Sediment Tank.*—A 12-in. rising main is carried under the river to the upper site, where it discharges into a carrier connected with an open tank

built in three compartments, each 90 ft. by 30 ft. by 10 ft. in depth, with a total capacity of 500,000 gallons, or 24 hours' dry-weather flow; the sewage, after travelling the whole length of the three compartments, in all 270 ft., flows into the main carrier to the primary beds.

The tank is built of concrete with blue brick copings, the inlets and outlets being submerged. Provision is made by means of floating arms to empty either section through a drain back to the pump wells, the sludge to be brushed through outlet valves and open channels to a sludge pit which is also drained back to the pumping station.

Main Carrier.—This is carried along the upper part of site, being 950 ft. in length, constructed of concrete coped with vitrified brick, excepting the central portion, which is built as an aqueduct in brickwork, 82 ft. in length and 16 ft. from the ground line in the centre.

Contact Beds.	Primary.	Secondary.
No. of beds	8	8
Size	80 ft. by 70 ft. ..	78 ft. by 75 ft.
Depth	3 ft.	3 ft. 3 in.
Area of each bed ..	622 sq. yds.	650 sq. yds.
Total area	4976 sq. yds. ..	5400 sq. yds.

The beds are constructed of cement concrete 1 to 5, walls 18 in. in thickness coped with cement. Bottoms in 6 in. of cement with a fall of 12 in. from inlet to outlet rendered in the primary beds.

The secondary beds are underdrained by 6 in. and 4 in. land tiles.

Filling to Beds.—The contract provides for all beds being filled with clinker, the total quantity being 12,000 cubic yards, price 6*s.* 6*d.* per yard, but the difficulty of obtaining this large quantity of hard clinker and the tendency shown by clinker to break down decided the council to abandon it for the primary beds and to seek other materials. The alternative materials that could be obtained locally were ironworks slag from Westbury, and limestone from Frome. At this time in the neighbouring town of Devizes the town council under Mr. Dibdin's supervision, were carrying out experiments with waste slate. The committee visited these works, and were much impressed with what they saw and the results obtained there. The Author was

also carrying out a series of experiments on a small scale, using slate, limestone, broken brick, slag and clinker, and the consulting chemist, Mr. C. J. Waterfall, F.C.S., F.I.C., of Bristol, reported very favourably on slate and limestone, the former giving better and the latter nearly as good results as clinker. It was consequently decided to fill four of the primary beds with Tytherington limestone as being in the Author's opinion harder than the Frome stone, and four with slate laid under Mr. Dibdin's directions as follows:—Single rows of blue vitrified bricks are laid flat on the floor in the direction of the fall, varying from 2 ft. to 2 ft. 9 in. apart; on this the thickest slates, about $\frac{3}{4}$ in. in thickness, were laid, above the slates are carried up in layers 2 in. apart with slate cubes for support, 10 ft. apart in every direction, the slates are built round a 10 in. wooden cylinder having holes for flushing out the bed when required.

Slate beds having a water capacity of 50 per cent. greater than limestone or clinker, the Local Government Board were asked to sanction the primary beds being reduced from 8 to 6, but declined, on the ground that slate for filling was a new material of which they had had no experience, the result being that there are two spare primary beds.

The secondary beds are filled with broken clinker screened to pass a 1 in. and rejected by an $\frac{1}{8}$ in. mesh. The final effluent is collected in carriers for distribution over about 6 acres of land or conveyance direct to the river.

COST OF WORKS.

The contract for the work was as follows:—

	£	s.	d.
Incidentals including provision for railway siding ..	225	0	0
Contact beds	9785	4	1
Sedimentation tank	2152	7	7
Sludge pit and carriers to same	191	4	8
Stormwater bed	931	5	5
194 yards 21 in. outfall sewer and manholes	485	12	5
Effluent drains, collectors and outfalls	313	13	11
12 in. C.I. rising main with manholes and hatch boxes	486	4	6
Roads, bridges, culverts, gates and fences	1900	11	9
Tanks, pumping station and chambers	3762	6	3
Provisional sum for machinery	1500	0	0
Contingencies	1000	0	0
Total ..	£22,733	10	7

The contractor for the general works was Mr. J. Riley, of Cheltenham, and for the gas plant, engines and pumps, the National Gas Engine Co., Ashton-under-Lyne.

Mr. C. S. Cole, A.M. Inst. Mech.E., the son of your genial secretary, carried out the duties of resident engineer.

DISCUSSION.

Mr. W. J. Dibdin explained in detail the development of the theory of the use of slate as a filling for bacteria beds. To avoid unnecessary repetition the reader is referred to volume xxxii., p. 339, where the subject is fully dealt with and illustrated.

As to cost Mr. Dibdin said: The cost of these slates, split as you see, and including the necessary number of blocks, put on the rails, is 10*s.* per ton. As each ton of slates will fill three cubic yards the price at the quarry is 3*s.* 4*d.* per yard. To that you must add the carriage, cartage, and cost of laying. The cost of these beds for all charges is 9*s.* 3*d.* per cubic yard, that is, built into the bed in the way you see. One cubic yard of slate will take as much sewage as two cubic yards of coke or clinker. As a matter of fact it starts with doing nearly four times as much, and reckoning it only does twice the work it is equal to coke beds at 4*s.* 7½*d.* per cubic yard, with the further advantage that the slates are indestructible. They will never wear down by the action of the sewage or bacteria. And we find by experiment, after eighteen months' working at Devizes, that the deposit on the surface of the slates was in such a loose friable state that it could be washed off simply by a flush of water. For this purpose you will notice in the beds certain places which cover a flushing shaft, which is made by simply putting in a wooden template in position, and building the slates up round it. Then that is taken out, and there is a flushing shaft. It may be, according to the experience at Devizes, eight or ten years before these beds require to be cleaned out. But whatever the period may be, a hose with a bent nozzle can be put down the shaft and the deposit washed off and run on to a special ash or clinker bed, on which it can be dried without any nuisance or trouble whatever. Of course there is a certain amount of labour, but it is of such a minimum character that it becomes a very small matter indeed.

In reply to questions Mr. Dibdin said: The 3*s.* 4*d.* is the cost at the quarry, that includes the cost of splitting the slates, which may be done at the quarries, or at the beds. The experimental slate bed at Devizes ran for eighteen months, doing four times as much work as the large beds, and then had a working capacity of 50 per cent. So I think we may reasonably consider that the beds will run for eight or ten years. Here, at Trowbridge, the sewage will go into the depositing tank before it runs on to the slate beds. At Devizes the sewage is turned on to the slate bed without any screening or tank at all. A new clinker bed will hold 50 per cent. of its capacity, but by the accumulations the capacity is reduced to 33 per cent. as the ordinary working capacity, and, if you do not precipitate your sewage first, to 25 per cent. In these slate beds the water capacity will be at first 87 per cent., and after eighteen months working at Devizes, where we treat the crude sewage on the beds, we had 50 per cent. of working capacity. Then we flushed out the beds to see how they would behave. We found a bucket of water washed the deposit off the slates.

Mr. R. Read: I beg to propose a vote of thanks to the authors of the papers, and to Mr. Dibdin for his able description of the slate beds. I congratulate Mr. Lailey on the very admirable work he has done in Trowbridge. The work of relaying a system of sewers is, in many respects, more difficult than the laying of new sewers. It is always a great difficulty to get ratepayers to see that it is their duty to connect their drains to the public sewers. It took me something like three years to get 3000 houses connected with the new sewers in Gloucester. The work here appears to have been very well done. The new departure in the construction of bacteria beds by slate filling is of particular interest to the members, and I hope it will prove a success.

Mr. J. Lemon: I have very much pleasure in seconding the vote of thanks. It is certainly surprising to me to find that sewers laid so recently as 1872 were brick sewers four feet in diameter. Mr. Dibdin has shown us the way out of the sludge difficulty, and I wish him every success.

Mr. A. Gladwell: I should like to know how many diseases are treated at the isolation hospital. The figures which are given would be very much modified if the detailed cost comprehended the treatment of other diseases beside that of

scarlet fever, which is generally the prevalent disease. The sewage to be dealt with is of a very difficult and complex character. It will be not only of local interest, but almost of national interest to watch the progress of these works, seeing there is such an important departure in sewage treatment as Mr. Dibdin's slate beds. I trust that it may be possible some day to have an amplification of these papers, showing the results of some years' experience of treating the sewage on the lines we have seen to-day.

Mr. A. P. I. Cotterell: It appears that a great deal of trade waste of different kinds will be treated, and one is anxious to see what effect that will have upon the general purification. It also looks as if gas liquor will be taken into the sewers. In going over the big septic tanks this morning I did not see any provision made for clearing away the sludge. Were they designed in days when they thought there would be no sludge? Because there will be need to take away the sludge which will be collected in the bottom of the tanks. Mr. Dibdin has introduced a new departure which many of us will be glad to adopt, or get his advice in adopting, so as to secure the better efficiency of our filter beds. I was not able to follow Mr. Dibdin's description of the cleansing of the beds. I understood him to say they put in a hose pipe with a bent nozzle, and washed away the deposit on the slates. The tendency would be for the solids then to collect in large masses. What arrangement is made for clearing the accumulated sludge away and getting it on the land?

Mr. Lailey: I desire to thank you very much for the kind words spoken about me. With regard to the question raised by Mr. Lemon as to the size of the main intercepting sewer laid in 1872, it has always been a puzzle to me and to my predecessor, Mr. Stanley, as to why this sewer was constructed of such large proportions; it may have been meant for a tank sewer, so that when the river was in flood the sewage and flood water would not back up into the subsidiary sewers and house drains.

In reply to Mr. Gladwell: the Infectious Diseases Hospital is a joint one, and takes in cases of scarlet fever, typhoid, diphtheria, and erysipelas. I believe the joint authority are making arrangements for erecting a pavilion for dealing with small-pox.

Mr. W. H. Stanley: I am very pleased to meet the

members of the Association, and thank you very much for the way you have received my paper. As regards the sludge, it is proposed to deal with the detritus at the pumping station by lifting it from the grit chamber by bucket pumps worked off the gas engines, the sludge will be pumped with the sewage to the large sedimentation tanks on the upper site from which it can be swept through open channels to a sludge lagoon, and when in a fit condition to handle, taken out mixed with ashes and dug in surplus land there. The main outfall sewers have been relaid and deep gullies placed in the roads, and under supervision the large quantities of grit and ashes that formerly found their way into the sewers will, I anticipate, be considerably reduced. In washing out the slate beds, arrangements have been made to take the scourings round the secondary beds, and to discharge over the irrigation area. At present we are not taking any liquor from the gas-works; the amount, however, is very small compared with the sewage.

Mr. W. J. DIBDIN: I thank you very sincerely for the manner in which you have received this vote of thanks. As to the gas liquor, that is an important point. I have had to examine the effect of gas liquor upon sewage in regard to its action upon the bacterial processes going on in modern sewage works very frequently, and in connection with a large number of places, and I have found this: if the volume of gas liquor does not exceed 2 to 3 per cent., then it is absolutely without any effect upon the bacterial activity in ordinary bacteria beds. If it is increased to 5 per cent. of the total volume, then the quantity is, under some conditions, sufficient to make you careful. It may have a retarding effect in this sense, that although the daily flow may be only 5 per cent. of the total volume of the sewage, they may not control the rate of discharge so that it does not at any time exceed 5 per cent., and you may have at times 8 or 10 per cent. If that is the case, you must have a sterilising process, and that is objectionable. The rate of discharge from the gasworks into the main sewer should not exceed 5 per cent., and if you can keep them to that limit then no harm will be done, but don't let them get beyond that. The other point is as to the cleansing of these slate beds. After eighteen months' work at Devizes, I was anxious to know whether this was going to be a success or not. So we

cleared out the bed and exposed the slates, and then it proved to be such a loose, friable material that it flushed off the slates, and left them perfectly clear. It was obvious that a simple flushing would clear it off. Then comes the question, after you have washed it off the slates, what are you going to do with the residue? What residue is washed off the slates is put on the porous ash-bed, and it will drain and dry without nuisance and without trouble and expense. That is the experience of the work at Devizes, and that is the best answer.

DESCRIPTION OF THE SEWAGE DISPOSAL WORKS AT DEVIZES.

By W. J. Dibdin, F.I.C., F.C.S.

The payment of interest on capital, repayment of loan and working expenses of these beds to-day are no greater than were the previous working expenses, so that the installation before you has cost Devizes practically nothing at all. With reference to the question of flushing the slates, I have gone into this with the surveyor, Mr. Billingham, and he concurs in the view that it would not take a day to cleanse one bed. At this rate eight days in some eight or ten years will be all the work required to keep them in working order, but precise data cannot be obtained other than that I have already given in connection with the experimental plant, until time permits. The deposit which drains away from the beds at the end of each discharge used to be sent on to the fine beds from whence it was removed, and you will be able to see how it dries up and weathers without expense or nuisance. At present this matter is diverted on to a special drainage area on the withy bed. The whole of the sludge produced from this strong sewage during the past nine months is before you, and you will see that the effect is satisfactory. It must be pointed out that the sewage of Devizes is of an exceptional nature, and it is not presumed that at all time the highest class of effluent is obtained therefrom by simple double contact, as we have something like a mile of grass land to irrigate the effluent over. Had it been considered desirable to do without land treatment, we should have decided upon treble contact, the room for which, as well as excellent fall, is available, so that, if at any future time it should be deemed necessary, additional beds could be put up at a comparatively small cost. The great point is that we have completely met the difficulty with regard to the sludge question, and at the same time brought peace to the town in respect to the various

trade refuse liquors which are freely admitted to the sewers in even larger volume and greater variety than before the construction of the present works. You will notice that the sewage is run direct on to the beds, except in time of storm, when it is turned into the detritus tanks, which are subsequently emptied on to the withy bed with the resulting deposit; and it is noticeable that this deposit takes longer to dry, and creates more nuisance in the process, than does that from the slate beds, as it naturally contains a certain proportion of crude, undigested sewage matters of a highly nitrogenous nature, which have not been subjected to aerobic bacterial action.

Leaving the Town Hall, Trowbridge, the Members proceeded to the sewage disposal works, where the new slate-filled bacteria beds were inspected.

The Members were then entertained, at the kind invitation of Mr. Herbert Mundy, to luncheon at the George Hotel, Trowbridge.

The party then drove to Devizes, where the sewage disposal works with slate-filled bacteria beds in operation were inspected.

HOME COUNTIES DISTRICT MEETING.

September 29, 1906.

Held in the Guildhall, Windsor.

J. PATTEN BARBER, M.INST.C.E., PRESIDENT, *in the Chair.*

THE Members were received by Sir Walter Shipley, the Deputy-Mayor, in the unfortunate absence of the Mayor, by reason of serious illness. Sir Walter offered the Members a hearty welcome to Windsor.

Mr. C. H. Cooper, of Wimbledon, and afterwards the President, on behalf of the Association, thanked the Deputy-Mayor for the kind welcome he had given them.

Mr. R. J. Thomas was unanimously re-elected Honorary Secretary for the Home Counties District.

THE MUNICIPAL WORKS OF WINDSOR.

BY ERNEST ALBERT STICKLAND, ASSOC.M.INST.C.E.,
BOROUGH ENGINEER AND SURVEYOR.

THE Author has great pleasure in presenting to the Members a short paper descriptive of Windsor and its municipal works.

In preparing these few notes of municipal work in Windsor, or New Windsor, as it is termed in contradistinction to Old

Windsor, some two miles distant, it is hoped a few words in connection with that magnificent and imposing pile of architecture which overlooks the surrounding country for many miles may not be out of place; the Author refers to Windsor Castle. The town of Windsor has of itself little or no history; it has no trade of importance, nor has it ever stood out conspicuously in any of the civil contentions of the kingdom, from which many other cities and towns have suffered.

Edward the Confessor granted the ancient town, called "Windleshora" by the Saxons, to the monks of Westminster "for a perpetual inheritance to those who serve the Lord for the praise of Almighty God"; William the Norman decided to build a royal residence at Windsor, thus originating the now world-renowned structure. The history of England is closely intertwined with the history of the Castle, and it would be impossible in a paper of this description to give even a faint idea of the great and glorious incidents which have occurred within its walls.

It might, however, be mentioned in passing that King John was here besieged by his barons, and at Runnymede, in the vicinity, the famous grant of "Magna Charta" was obtained from the reluctant king. The justly celebrated St. George's Chapel was begun by Edward IV. and finished in the time of Henry VIII., and is one of the finest examples of perpendicular architecture in existence. The Albert Chapel occupies part of the site of the Chapel of Henry III.; it was rebuilt by Henry VII. and given to Cardinal Wolsey by Henry VIII. It was repaired by George III., who caused a vault to be excavated beneath it.

As kings and queens succeeded one another, so each in some way added to the existing edifices. George III. laid a considerable portion of the land under tillage, and George IV. spent a million of money, granted by Parliament, in enlargements and decorations; his majesty also added 90 ft. to the height of the round tower, and made great improvements in the park. During Her late Majesty Queen Victoria's reign the mausoleum at Frogmore was erected, in which now rest the remains of Her Majesty and His Royal Highness Prince Consort. The ornate decorations of the Albert Chapel were carried out during Queen Victoria's reign, together with numerous improvements which space alone prevents particularising.

Municipal Government.

Windsor was first incorporated in the year 1276, the fifth year of the reign of Edward I., from which time it continued to be the county town till 1314, when the honour was transferred to Reading. The charter was confirmed by successive monarchs, until Charles II. granted a new one (vesting the government of the town in a high steward, mayor, two bailiffs, and twenty-eight burgesses), which continued in force until the passing of the Municipal Act. The Council now consist of 6 aldermen and 18 councillors, and they act as the Urban District Council and Burial Board. The Waterworks are also the property of the Corporation. The area of the borough is 2582 acres; of this about 2232 acres are Government property, so that the actual building area, including roads and footpaths, is about 350 acres. Nearly the whole of this area is built upon, only a very small quantity of land being at present available for building.

The population of the borough in 1891 was 12,397, and in 1901 it was 13,958. The rateable value is £85,070; a penny rate producing less than £290. Whilst on the matter of rating, it may be of some interest to the Members to be informed that Windsor Castle is exempt from rating, with the exception of a small portion occupied by the Dean, the military knights and choristers. The Castle deals with its own sewage, refuse, etc., and has a separate water supply.

In the borough there are two barracks occupying some 27 acres of ground; these premises again are not rateable, but the Crown authorities make a voluntary contribution towards the rates. Within the last few years the War Office authorities have purchased a number of houses and other property, including one road, for the purpose of extending the infantry barracks; up to the present time the only action taken has been to turn out all the tenants and board the site up. The closing of this property means a loss of £927 on the rateable value of the borough.

Corporation Depot.

In 1898 the Author was instructed to prepare plans for a store yard and depot. The work has been carried out at a cost of £8058, viz.: land, £2463; buildings, £4332; and horses and carts, £1263.

The buildings comprise: House for horsekeeper; stabling

for sixteen horses, the block being divided into four sections, by means of a corn store and harness rooms; smith's, carpenter's, and painter's shops; roller shed; tool stores; mess room; lime and cement stores; two sick boxes, well away from the main block of stabling; cart sheds, and stores over same. The shape of the site is a parallelogram, and the buildings occupy three sides. The centre is kept clear, and tends to facilitate the work of the department. The Surveyor's and Inspector of Nuisances' offices are situated at the entrance of the yard, enabling an amount of supervision over the work and men not attainable when the offices are away from the yard. The whole of the buildings are lighted by electricity, and electrical power is used to cut the chaff, crush oats, keep the blacksmith's fire going by means of a centrifugal fan, etc.

The horses are always fed on crushed oats and chaff, the weekly cost per horse being as nearly as possible 15*s.*

The air space per horse in the stables is 1949 cubic feet, and the superficial area per horse is 121 feet.

Roads and Streets.

The total length of roads repairable by the Council is about 12 miles. On one half of this length Enderby granite is used, and for the other half local gravel. The Berks county council contribute towards the maintenance and repair of 3 miles 7 furlongs of roads and footpaths, the average annual contribution for the last eight years being £2372. The largest payment made was £3151 in 1904, and the smallest £1452 in 1898. Since 1897, when the Author was appointed surveyor, a great deal has been done towards the improvement of the roads and footpaths, the Council having adopted a system of carrying out improvements gradually, and a vast amount of work still remains to be done. The main roads and principal streets of the borough are being re-curbed and re-channeled; the material used is 12 in. by 6 in. Norway granite, laid flat on a bed of 6 in. of Portland cement concrete. The footways are being laid with 2 in. indurated stone, taking the place of asphalt and York stone.

In the residential districts, 6 in. by 12 in. blue Pennant curb is being substituted for Denner Hill stone. In every case where the Denner Hill is taken up, that material is re-dressed,

and made into setts 4 in. wide, and random lengths. Channels are formed of these re-dressed setts, in every case the channel being not less than 12 in. wide, all laid on a bed of concrete, 6 in. deep. In the side streets the Council have also adopted patent paving in place of the existing asphalt paths, and alterations and improvements are slowly taking place.

In 1898 the Council decided to replace the existing gullies with a later type. Up to the present 248 have been substituted, and 225 more are required to complete the work.

The actual expenditure on roads, curbs, channels and footpaths during the last five years has been over £27,600.

Street Cleansing and Watering.

The borough, for street cleansing purposes, is divided into beats, one man to each, who collects the sweepings into handbarrows and disposes of them at the most convenient points. The Council possess two rotary horse brooms which are used in wet weather, the mud being collected in drums and carted to the nearest shoot. In addition to this, the main streets are handswept every morning, two carts being employed for this purpose together with the emptying of the various street orderlies. The average annual cost for scavenging during the past three years was £1092 6*s.* 2*d.*; this amount is what is actually paid for carters' time and labour, the horses and carts not being included.

Street watering is carried out by means of three vans fitted with Glover's patent sprinklers, one Willacy patent van, and four ordinary box distributing water vans. The average quantity of water used during the past three years was 3,874,000 gallons, at a cost for water alone of £96 17*s.* The cost for distribution being £183 10*s.*

Westrumite, Akonia, and calcium chloride have all been used for the purpose of dust prevention, but no really satisfactory and at the same time money-saving preventives have been discovered.

The Windsor roads are cleansed every Sunday of the year, and watered on hot, dry, and dusty Sundays.

Street Lighting.

Windsor was one of the first towns in England to wholly adopt electricity for street lighting purposes. In March 1899,

the use of gas was discontinued, and all the streets and passages were lighted with the electric current. Ten 2000 c.p. lamps, nineteen 500 c.p. lamps, and 260 double 16 c.p. lamps are now in use; the actual annual cost being £1412. The standards carrying the twin lamps are arranged on alternate sides of the roads, and about 60 yards apart. The electric light is supplied by the Windsor Electrical Installation Company, Limited.

The lamps are lighted from one hour after sunset to one hour before sunrise, all the year round, except that the 2000 and 500 c.p. lamps are switched off nightly at 11.30, and a smaller light turned on in lieu thereof.

Refuse Collection and Disposal.

Refuse is collected once a week from every house; but in certain parts of the town a daily collection has to be made, on account of the small yard space belonging to the various properties. Trade refuse is also cleared away upon payment, as is also offal from butchers' and fishmongers' premises. Five vans and two carts are engaged in the work of refuse removal. The offal is moved every morning between 6 and 8 a.m. in specially constructed air-tight tins. The Corporation enforce the use of sanitary bins as much as possible, as this facilitates the removal of ashes, etc., and more especially as in nearly every case the scavengers have to carry the refuse through the house. The refuse from the two barracks is collected by a contractor at an annual cost of £80.

The cost of the removal of house refuse other than the above-mentioned contract is £1230 per annum.

The Corporation for many years considered the question of erecting a refuse destructor, but whilst recognising that fire was the most efficient means for the disposal of refuse, the great difficulty was the provision of a site. In 1900 an application was made to the Local Government Board to borrow money to erect a destructor on a piece of land belonging to the Council at the back of the infantry barracks; unfortunately that was opposed by the War Office, consequently the Local Government Board withdrew their consent; the ground was afterwards purchased by the War Office.

In November 1902 the Corporation applied for compulsory powers to purchase a site adjoining the surveyor's depot, and as

a matter of fact a provisional order was drafted by the Local Government Board sanctioning this site, but certain representations were made, and it was struck out of the order. For years past the Corporation had been depositing the town's rubbish in a field at Clewer, situated one mile west of the borough boundary; as was only natural complaints were made by the Rural District Council, as well as residents in Clewer, of the nuisance arising from the tip. However, in July 1903 a letter was received from the Local Government Board inquiring if there was any objection to the erection of a refuse destructor on the land at Clewer; and upon receiving this the Council decided to proceed without further delay in the erection of their destructor. After the most careful consideration the town Council decided to erect a destructor, and the sanction of the Local Government Board was obtained for this purpose.

The cells are two in number, constructed on the improved patent back-feed type, the clinker doors being in front and feed holes at back; the grate area is 30 ft. per cell, with forced draught controlled by separate valves to each cell. Provision is made in the arrangement for increasing the capacity of the plant by two additional cells. The boiler is a water-tube boiler of the Babcock and Wilcox type, with a working pressure of 120 lb. to the square inch. A direct-acting fly-wheel feed-pump and self-acting ejector are arranged for filling the boiler.

The patent centrifugal dust-catcher is 13 ft. in external diameter, and 12 ft. in height from ground line to springing of dome. The chimney is 6 ft. internal diameter inside the lining, 90 ft. from ground line to the summit, constructed on the "Custodis" principle; the pedestal is 10 ft. square, but the shaft is circular. An overhead railway is provided, together with two strong skips hung on trunnions, to facilitate the quick removal and tipping of the clinker.

There is also a mortar mill, driven by a steam engine direct.

The buildings are constructed of local stock bricks, with red brickwork in arches and other ornamental work. The roof is constructed of iron and steel, boarded over and covered with slates. A ventilator is provided, running the whole length of the building. The two ends are filled in with corrugated iron on wood frames, so arranged as to allow for future extension.

On the same site the Corporation have erected a couple of

cottages for the attendants, a weighbridge and office, stabling for horses, lime and other sheds, together with a disinfecting apparatus and house for same.

The disinfecting apparatus has proved very serviceable and convenient.

The whole cost of the work, including the formation of the inclined roadway, tipping platform, etc., was £6258 12*s*. 7*d*. The contract was £3890 3*s*. 7*d*.

The works have been in operation about fifteen months, and during the first year the amount of refuse destroyed was 2523 tons, representing 2779 loads.

The clinker has been used for various purposes; mortar is made and sold to builders in the neighbourhood at a price of 7*s*. 6*d*. per yard delivered. The ashes are used for making the bottoms of gravel footpaths; they are also sold to farmers in the district. The Author hopes to obtain the consent of his Council at an early date to make paving flags of the material.

The tins collected in the refuse are picked out and sold to the Electron Works Company at 15*s*. per ton. Light scrap-iron is sold to the same firm at 10*s*. per ton.

The dust collected in the refuse dust-catcher and flues is mixed with carbolic acid and used by the ashmen for disinfecting purposes when the sanitary bins are emptied.

Sewers and Disposal of Sewage.

In the years 1850 and 1851 the Windsor of that day was provided with a complete drainage scheme, the sewers ranging from a 9-in. pipe to a 4 ft. by 3 ft. brick oval sewer. The whole of the surface water and sewage at that time passed into the Thames; the outfall, passing through the Crown property, emptied itself about one mile due east from the centre of the town.

In 1875 a 4 ft. 6 in. brick circular outfall sewer about 3720 yds. in length was constructed, extending from a point where the existing sewers entered the Crown property on its way to the Thames, to the new sewage farm at Old Windsor. This sewer, when broken into some eighteen months ago, was found to be in first-class condition.

The system of drainage laid out in 1850 has been extended as required by the opening up of new roads, but the sewers are

still of sufficient capacity to deal with the added quantity. For a great many years past a large number of houses and streets of the adjoining district of Clewer have, by arrangement, been draining into the Windsor system. By an agreement dated the 10th day of June, 1903, between the Corporation of New Windsor on the one part and the Windsor Rural District Council on the other, the whole of the drainage of Clewer will be taken into the Windsor system on payment to the Corporation of an annual sum of £300, and also upon the payment of agreed sums towards the working expenses thereof.

At the present time the Clewer authority are carrying out a complete drainage scheme for their district: to enable this work to be carried out satisfactorily, it was found necessary to construct 951 lineal yds. of 21-in. iron-pipe sewer, at an average depth of 27 ft., within the borough. Acting upon the advice of the Author, the Corporation considered the question of increasing the size of the 21-in. pipe, and finally decided to construct a 5 ft. by 3 ft. 4 in. brick sewer, this being sufficiently large and deep to take all the drainage of Windsor, if necessary, at some future date. The rural district council contributed the estimated cost of their 21-in. iron pipe towards the cost of the brick sewer. The actual sum expended on this work was £6235, and it was completed last October.

The sewage works and farm lie to the south-east of the borough, on an island called Ham Fields, formed by a bend in the river Thames and the new cut. The total area of land available for sewage disposal is 39 a. 2 r. 33 p., which is farmed by the Council at a profit. This area does not include corners, banks, land occupied by pumping station, cottages, etc., but is the area that can be placed under irrigation. The system of sewage-disposal adopted is that of broad irrigation, the substratum consisting of gravel; and at no time is there any difficulty in getting rid of the sewage; the actual quantity dealt with averages 1,355,000 gals. per day. No complaints have been made of this method of treating the sewage, or of the character of the effluent, either by the county council or any other authority.

The total cost of the 4 ft. 6 in. brick sewer, together with the sewage farm, buildings, etc., was over £51,000.

New Police and Fire Station.

In the early months of 1904 the Author was instructed to prepare plans for a new police and fire station, to be erected on a piece of ground in St. Leonard's Road. The plans were prepared, and, after being approved by the Council, were forwarded to the Surveyor of Prisons for his approval. The regulations of the authorities have been complied with as to size of cells, ventilation and heating of same, and provision of rooms for the various requirements of the Home Office. As regards the cells, the temperature of a cell has to be maintained by artificial means at a temperature of 63° when it is 32° outside. Lucky prisoner! A premium was offered by the Council for suitable elevations to fit the plans already prepared. Some 66 designs were submitted, and the drawings selected were carried out.

In carrying out the building, this elevation has been worked to as nearly as possible, but the whole of the details, both inside and outside, of the structure have been prepared in the office of the Author.

A tender was accepted at the price of £15,926. A commencement was made in May 1905, and on July 28 H.R.H. Prince Christian of Schleswig-Holstein, K.G., etc., laid a memorial stone at the main entrance of the building. The works are supposed to be finished about September 29, and are now nearly completed.

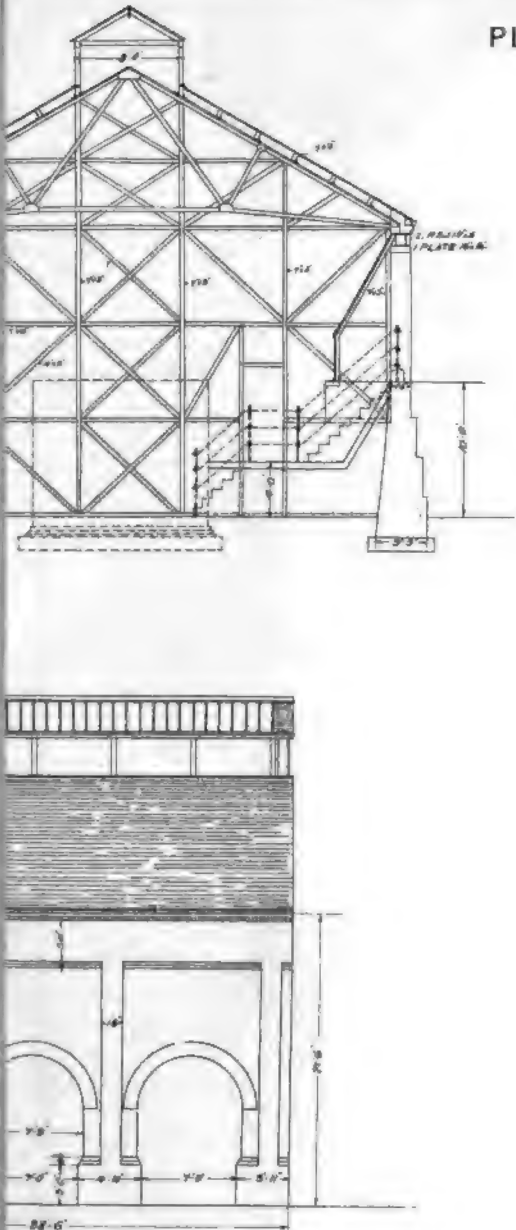
The land for the building was purchased from the Crown fo 1500*l*., the area being about 2504 sq. yds.

The materials used in the construction are No. 5 Lawrence' red brick, and Victoria stone dressings for the elevations, o which there are three. The brick for the internal work and fo the buildings facing the yard are Itter bricks, from Calvert nea Aylesbury. The whole of the mortar used has been supplie from the refuse destructor mortar mill.

The hall and staircase have been constructed with yello Mansfield, with black Devonshire marble half-columns, and th steps of Victoria stone. The police-court is 45 ft. by 25 ft., an 24 ft. high, panelled with oak for a height of 8 ft., and adjoini this is a magistrate's retiring room and solicitor's room.

Eight cells have been built, lined with white glazed bri from floor to ceiling. The corners are all rounded, and t ceiling and floor treated in a similar manner where they join

PLATE No. 1.



UCTOR FOR WINDSOR.

ILDINGS.

To face p. 48.

PHOTO LITHO. R.J. EVERETT & SONS, 15 BARTLETTS BUILDINGS, HOLBORN ...

walls. Each cell is provided with a radiator, air inlet and outlet, electric light, and call bell. Lavatory basins and w.c. are arranged at each end of the corridor. A range of offices are built for the purpose of the police business, with a committee room, retiring room, and clothes store over, approached from the main staircase. At one end of the police station the head constable's house is placed.

Overlooking the yard are rooms for the caretaker, accommodation for six single constables, together with a parade room and recreation room. A wash and brush-up room, drying room, w.c., bath-room, and lamp-room are also provided for the day police. Beneath the police-court and offices is a large hall 104 ft. long by 25 ft. wide, approached by means of two flights of steps from the street. On the basement floor provision is made for a boiler-house, a lock-up store, and a public convenience, this latter being approached from the street by a flight of granite steps.

The fire station adjoins the police station, but is disconnected from it. Under the floor of the building are a workshop, bathroom, lavatory, and w.c. for the firemen. The Windsor fire brigade is a volunteer one.

Arrangements have been made for the engineer in charge to have living rooms over the fire station. At the rear, a recreation room is provided for the firemen.

The visit the Members will pay to this building will, however, give them more information than the Author is able to convey in this paper.

Public Conveniences.

In 1898 two large cellars under the Guildhall were transformed into public conveniences, one for each sex, at a cost of just over 1000*l*. The old walls and arches were lined with Crystopal tiling, and this has proved fairly successful; the fittings are of the usual character found in similar buildings, and call for no further comment.

A public convenience—which the Members will have an opportunity of inspecting—has been constructed under the new police and fire stations.

Public Gardens, etc.

Windsor, with its Home Park, Long Walk, and other attractions connected with the Castle, is fortunately situated as regards

the provision of pleasure grounds. For many years the Council have been endeavouring to improve a stretch of ground lying between the point where the Great Western Railway viaduct crosses the Thames and Windsor bridge. A year or two since, owing to the generosity of Sir Francis Tress Barry, Bart., who was at that time M.P. for the borough, the Corporation were able to deal with this land; the ground for the gardens was purchased and presented to the borough by the Member, the Council bearing the cost of making the roads and paths and laying out the site. A large amount of work has already been done, over 6000*l.* having been spent, and a great deal more remains to be done to carry the scheme to a successful issue.

CEMETERY.

The Corporation act as the Burial Board. In 1901 the Author prepared plans for an extension of the cemetery, which included boundary walls, curator's house, mortuary, laying out of roads and paths, together with necessary drainage, etc. The whole of these works cost £5500. The area of the extended portion is 5½ acres.

A SHORT DESCRIPTION OF THE WINDSOR CORPORATION WATERWORKS.

By C. SAINTY, M.Inst.Mech.E., Waterworks Engineer.

These works were purchased by the Windsor Corporation from the "Windsor and Eton" Waterworks Company in the year 1888 (after a long and tedious arbitration), the authorised capital being £194,780, of which sum £160,000 was paid over—including the fees and costs. The Corporation took them over as a going concern, and like many other municipal undertakings in this country, an exorbitant price was paid for the works. At that time, there was the present waterwheel, which was in existence in the year 1830, and two of Cutler's (the original proprietor of the works) balanced outward-flow turbines, each turbine working two 9-in. pumps with a 2-ft. stroke. These two turbines were erected in the year 1873.

There was also a small steam engine of the old grasshopper type, working a set of 7½-in. 3-throw pumps with 12-in. stroke, and an old-fashioned horizontal steam engine driving a set of 12-in. 3-throw pumps with a 20-in. stroke, and two old Cornish boilers. Needless to say, after a very short time the steam boilers were condemned by the Boiler Insurance Company, and they, and also the two old engines named, were sold as scrap iron.

Upon his advent here, in March 1891, the Author found the waterwheel in a very bad state, so that it cost over £100 to repair. The Cornish boilers were taken out and a new locomotive type one put in; also there were two new turbines just set on their beds, and the pumps for them were ready to be erected. These were put in and started in November of that year; also a compound jet condensing Worthington engine, made by Messrs. James Simpson and Company, their capacity

being 400,000 gallons in twenty-four hours against 250 ft. head.

In 1899 a new steel Cornish boiler 18 ft. by 5 ft. 6 in., with 2 ft. 9 in. flue tube, was supplied and fixed; also a new compound duplex 12¼ in. and 19 by 12 by 12 in. pumping engine was supplied and erected. The Author may here note that this engine ran in 1903 for three months day and night without a stop, and pumping against a 150 ft. head all the time—quite a record, in his opinion, for this class of engine.

In 1903 a new well, 20 ft. internal diameter, cased with cast-iron cylinders, was sunk at a depth of 35 ft., being 10 ft. into chalk.

In 1904 a new 12¼-in. and 19 by 12 by 12-in. compound condensing engine was put down, a duplicate of the one before named, except in the condenser; the steam power is used when the river is in a state of flood, or when it is below the normal level, as it has been for several weeks this summer, owing to the very dry season.

Not having storage of any kind, we are entirely dependent upon our pumps day and night, which is a great anxiety to the one in charge, as Eton, Eton College, Eton Wick, The Cloisters, Windsor Castle, and Clewer, as well as the borough of Windsor, are all supplied from these works.

When the Corporation purchased the works, there were about 10 miles of mains in the district; now there are 25 miles, and about 22,000 consumers, besides water used for street watering and flushing purposes in Windsor and Eton. Clewer, at present, do not water their roads, and their drainage is not yet completed.

The supply is very little used for trade purposes, as the brewers in the district have their own wells.

The water is analysed every three months, and the reports are always excellent.

There are five wells on the works: four are 8 ft. internal diameter, and the one—the new one named—20 ft.

A description of the turbine pumps was given by the Author in a paper read at the Meeting of the British Association of Waterworks Engineers at Leicester in July 1902. (See Transactions, Vol. VII.).

DISCUSSION.

Mr. C. H. Cooper: I have very much pleasure in moving a hearty vote of thanks to Mr. Stickland and to Mr. Sainty for their papers.

Mr. N. Scorgie: I have very much pleasure in seconding the vote.

Mr. T. W. A. Hayward: I should like to express, on behalf of the members of the Association as well as myself, the deep regret we feel on hearing of the illness of the Mayor of Windsor, and sincerely hope it may not be of long duration. There is a good deal of information in the paper before us which will be of material use to members. There is only one matter, however, on which I should like some further information. Mr. Stickland speaks of using in Windsor Messrs. Ames Crosta's patent gully. It is a gully which I have heard occasionally somewhat adversely criticised, and therefore should be glad if Mr. Stickland would tell us what his experience has been as to the general utility of this particular make of gully. I have used this gully for ten years, and hold a strong opinion as to its utility, as against the brick catch-pits or the ordinary stoneware gully, and for that reason should like to hear the opinion of other users.

Mr. J. Parker: I should like to know the amount of water evaporated per lb. of refuse consumed, and also the temperature of the gases in the combustion chamber. The paper does not give us sufficient data to test how the working of this destructor compares with other destructors. I have saved £360 per annum in coal for some years past, and at the same time got rid of an intolerable nuisance.

Mr. R. Brown: So far as rateable value is concerned, Windsor has a very small area under the control of the Municipal authority, and a population of only 14,000. The amount of money spent on some of your works would really startle some of the neighbouring authorities. Scavenging and street cleansing cost over £1000 per annum, which appears to me excessive. Of course Windsor may require to be kept up to a very different state to other districts. Then you have something like eight water vans to water the roads. That may arise from the fact that you must keep the streets of

Windsor thoroughly wet. I don't know whether you have any cyclists here, but if you have I should say you get complaints and claims for damage by side slip. I notice that for dust prevention Westrumite, Akonia, and calcium chloride have all been used, and Mr. Stickland adds that no really satisfactory and at the same time money-saving preventives have been discovered. I brought a cheap and effective preventive before the annual meeting of the Association and was laughed at at the time. The material is oil tar, which is a first-class material for laying dust. It is not a patented material, and only costs $\frac{1}{4}$*d.* per square yard for each dressing, while four dressings a year are sufficient. I contend that it will be much cheaper to use a material such as that to prevent dust instead of going to an excessive cost for watering. As to street lighting, it is not clear to my mind whether there are two 16-candle lamps in each lantern. Refuse disposal seems to be a very large item, it works out at 1*s.* 9*d.* per head. I dare say some of the Members in this room could tell you that in their districts it works out at from 6*d.* to 9*d.* per head. The Corporation of Windsor has been progressive enough to erect a destructor which is probably one of the best in the market. It no doubt does its work admirably, and I shall be pleased to hear if it meets the requirements of the district, and also to know the labour cost per ton of refuse destroyed. I should also like to know what the rates are in the pound. If a penny rate only produces £260, with what has been spent on lighting, scavenging, etc., I should say the rates are very high. The exemption of Crown property from rating is a very unfortunate thing for Windsor.

Mr. C. H. Cooper: As regards the proportion of water-carts, I do not think it at all too large. You have only to look at the road we have passed over on the way from the station to see how carefully it must be watered to prevent slipperiness. I quite agree with Mr. Stickland as to the various dust preventives. Tar dressing, the use of which has been advocated, after a short time turns into a greasy mud which a district like Windsor could not tolerate. As regards the cost of the removal of house refuse, the great question to be studied is the distance such refuse has to be carted. Any one who comes to Windsor, and sees the distance to the shoot, has an answer on that question. Windsor is most unfortunate in the

amount of property within the borough which is not rated. Again, it is unfortunate as regards development. The small amount of rateable property that has to provide the means for running the district must of necessity pay a high rate.

Mr. W. Calder: As an Australian member of the Association, it is the first opportunity I have had of attending any of your meetings.

I should like to say a few words as to dust prevention. I am quite in accord with Mr. Stickland in saying that Westrumite and these preparations of crude oils—at least in my experience in Melbourne—have proved a failure. Their beneficial effects are only temporary. The dust evil is a very potent evil in Melbourne; more so than here, where, if I may judge by this summer, you have scarcely any wind. We have high winds and long droughts, and the dust is a great trouble. The most efficient preparation we have used is distilled tar. Not the oil from distilled tar, on the lines of Westrumite. This distilled tar, when there is not too much oil taken out of it, will last for a year, and makes a clean surface in winter time.

Mr. C. J. Jenkin: I should like to ask the cost per yard of the treatment of the roads in Windsor by the various dust preventives which have been tried?

Mr. F. R. Phipps: I should like to ask Mr. Stickland, with regard to the sewerage, whether both surface water and sewage are conveyed to the sewage farm for treatment. I notice—and I am pleased to be able to congratulate the Council—that the sewage farm is able to be run at a profit. The area of the farm is only one acre to each three hundred and fifty persons, which is usually considered very small. The cost of watering and scavenging seems high, but in going round the town this morning I saw that the roads are very well attended to, and it is of course necessary, in a Royal borough like Windsor, to see that no cause of complaint exists.

The President: There are two points raised in the discussion; one with regard to cleansing and the other as to watering. It is quite easy for any one to read through a paper and say so much money is a good deal to spend for scavenging or for watering so many miles of road. Any one can do that. But it is impossible to make a just criticism of the cost of cleansing and watering without knowing something of the district and its requirements.

I learn from this paper that the streets are cleansed on Sundays, and I infer, therefore, that the Corporation are very careful to keep the streets at all times in a clean condition. It is evident from that fact that the standard of cleanliness as to streets is a high one in Windsor. If we are to have streets kept in a decent and satisfactory condition the ratepayers must be prepared to pay for it. Busy streets cannot be kept in a good condition of cleanliness unless they are cleansed frequently. Many ratepayers think that the proper cleansing of a street can be done at the same price as letting it be neglected. They complain of insufficient or infrequent cleansing, and expect that without any increase in expenditure more thorough and frequent cleansing can be carried out. Money is well spent when it is laid out in keeping streets in a thoroughly clean condition, and in providing an adequate supply of water for washing them and for the prevention of dust and mud. I think that the wisdom or otherwise of the expenditure must be judged by the result which is obtained for the money which is expended; and that we cannot say that too much or too little has been spent in the cleansing and watering of streets without knowing the condition in which such streets are kept by the amount expended on them.

Mr. STICKLAND, in reply: I am sorry we have not had a longer time for a discussion of this paper. I was hoping that the shortness of the paper would bring forth a useful discussion. There are, however, a few questions that have been asked this morning and which I will answer. The chief question is that of scavenging and watering. We scavenge the whole of our roads constantly and thoroughly. The roads and streets in the borough are divided up into sections, the length of each depending upon the amount of vehicular traffic passing over that section. Altogether there are twelve men regularly employed in cleaning the roads, and picking up sweepings and droppings. At certain times of the day the ash-vans leave the town to go to the refuse destructor, which is more than a mile outside the borough, and these take about one and a half hours for the journey. During this time the dustmen (who go with each van) are also employed in assisting to cleanse the streets. Some years ago we tried doing the work in sections. Before many days complaints came in to such an extent that the Committee felt bound to go back to the old system. We have

several courtyards in the town which are kept clean by the Authority, and this from a sanitary point of view is very necessary. The streets are watered four times a day, and even with this amount of attention the complaints received as to non-watering are fairly numerous. Windsor is peculiarly a show town, and we endeavour to keep the borough up to date. As to rates, last half-year the district rate was 2*s.*, and the previous half-year 2*s.* 1*d.* We endeavour to carry out our work as cheaply as we can, and I do not think, when you consider the amount of work executed during the year, that a 4*s.* 1*d.* rate is excessive.

I was appointed Borough Surveyor of Windsor eight or nine years ago, and very little had been spent on the roads for some years before that. Under the old turnpike trust there was very little provision for road maintenance and repair, and I have been endeavouring from year to year to bring them up to the standard which I consider ought to be maintained for a town of Windsor's standing in the country. We have spent about 27,000*l.* on the improvement of roads and footpaths, and I am of opinion that a similar amount will require to be spent before we can see them in the condition we should like to see them.

Mr. Hayward asked a question as to my experience of Messrs. Ames Crosta's gullies. I am very partial to those gullies, and I have always found them satisfactory. One thing is necessary—constant cleansing, and the more you cleanse them the better for the town from a health point of view. If you allow them to get full of mud to the bottom of the seal they are useless. If, however, they are regularly emptied and thoroughly cleansed, I don't think there is any fault to be found with them.

I should like to say that, in my opinion, the Council have a gold mine in their sewage farm. There are 18 in. to 2 ft. of top soil, and beneath this some 20 ft. of Thames gravel. It is like pouring water through a sieve. Almost as fast as you pass the sewage on to the surface it percolates and quickly disappears. The effluent, however, does not discharge into the River Thames. Occasionally the river has been known to rise and flood the farm, so that in addition to dealing with the sewage of the town, we are, in case of emergency, able to deal with the Thames water which overflows on to the land.

Ald. CLARK: I should like to mention one matter which has

been omitted; we do receive a considerable sum in lieu of rates from the Government.

The Members then visited Windsor Castle, going over St. George's Chapel and the Albert Memorial Chapel, under the guidance of the Right Rev. Bishop Barry. The State Apartments of the Castle were next visited. The Members were subsequently entertained to luncheon at the Guildhall. Sir Walter Shipley, Deputy-Mayor, presided. The President and other speakers expressed much regret at the cause of absence of the Mayor. The afternoon was devoted to a visit to the Waterworks and other public works of the Borough of Windsor.

METROPOLITAN DISTRICT MEETING.

November 16, 1906.

Held at the Institution of Civil Engineers, Westminster.

W. Nisbet Blair, M.Inst.C.E., Vice-President, *in the Chair.*

The Hon. District Secretary read the Minutes of the Battersea Meeting, which were confirmed.

Mr. J. Rush Dixon was unanimously re-elected Honorary Secretary for the Metropolitan District.

The following paper was read and discussed.

AN ADDRESS ON THE PLANNING AND CONTROL OF TOWN-EXTENSIONS IN GERMANY.

By T. C. Horsfall.

In the long period in which the two movements of population have been taking place in this country, the movement from the villages and small towns into large towns, and the movement from the central districts of large towns into the suburbs, similar movements have been taking place in Germany also. But though the movements have been the same in kind, there has been considerable difference in degree. The population of the large German towns has increased in higher degree than has that of our large towns, but the movement towards the suburbs has been less marked in Germany than here.

But the greatest difference that has to be noted between the two countries in connection with the movement of population,

is in the nature of the new districts which have been built to receive the increase of urban population. In this country, vast areas, on what were a few years ago the fringes of our towns, have been covered with new streets, nearly all of them narrow, which lie between long rows of small houses, all very much alike. In most of these new districts very little vegetation exists; from the windows of the great majority of the houses in them, no trees or flowering plants are to be seen; and, though most of our large towns have provided in the new districts a park or parks, which, as a rule, are kept in excellent and most attractive state, the immediate surroundings of the majority of the houses are so devoid of all that can create and keep alive desire to see beautiful things in the majority of the inhabitants, that the parks are not only distant in space, but are also remote from the thoughts and feelings of most of them. In our new suburban districts there is also a great lack of playgrounds for children. We all know that in the districts in question there is so little to facilitate the living of a full and healthy life that the aid of the public-house, the music hall, the betting agent, must be almost as welcome there as in the older parts of the towns. For men and women will have some change from the sensations created in them by monotonous work, and if they cannot get it, as many of them are willing to do, in the occupations made possible by the existence of the beauty of nature and of interesting human productions, will seek it in the use of alcohol and other dangerous ways. Of the Author's own beloved town, Mr. Justice Day has said that it is no wonder that cases of drunkenness are common there, as to get drunk is the shortest way out of Manchester.

The new districts of German towns are so constructed that a stranger often cannot tell, when he passes through one of them, whether it is inhabited chiefly by rich or by poor people, and almost everywhere the dwellings of members of different social classes are so much intermixed, that, except in a few districts of a not large number of towns, Germany is nearly free from the great evil which exists in all our large towns—masses of people of the poorest classes separated by such long distances from all families which live a full, healthy life, that most of their children hardly know that life of the kind can be lived. Nearly all the streets are wide, many of them are planted with trees; there are many small open spaces, made attractive with plants;

public buildings are so placed as to add interest to as large a proportion of the district as possible. The tree-planted street is considered of so much importance that the Statistische Jahrbuch deutscher Staedte, which is for Germans that which the Municipal Year-Book is for us, always contains a table which tells, not only how many parks a town has, but also how many tree-planted streets, and the total length of such streets. Thus we learn that Coeln, which has about 375,000 inhabitants, has 285 tree-planted streets, the length of which is 64½ miles, and that the manufacturing town of Elberfeld, which has 157,000 inhabitants, has 27 tree-planted streets, 19 miles long. In a treatise on the Housing Question, the Oberbuergermeister of Mannheim says that one of the duties of a community is to give some compensation to the working classes for the smallness of their houses by providing every part of a town with promenades, shrubberies, and playgrounds. It would be very difficult to overstate the value to the inhabitants of German towns of such places and of tree-planted streets. Large numbers of parents resort to them on summer evenings and on Sundays with their children, and while the children play in almost complete safety, the parents rest on the benches provided by the town. The Author's attention was drawn to the high value of planted streets and open spaces many years ago, by the statement made by one of the London coroners that he held, on an average, more than fifty inquests a year on children killed while playing in their only playground—the street; and he has therefore, ever since, tried to find out, when he has been abroad, how foreign children fare in respect of the chance of playing in safety. He has never found a German workman's dwelling from which a tree-planted street or garden could not be reached on foot by a short walk. The result of this one difference between our towns and German towns is that German town parents spend far more time happily with their children than do parents in our manufacturing towns, where, indeed, family life has almost died out. It is only the games of very young children that are here referred to. There is so great a lack of playgrounds available for the organised games of older children in German towns that, as is mentioned later, the new Prussian Housing Bill explicitly gives municipal authorities power to provide such grounds in sufficient number, though the power was implicitly given in an Act in 1875.

The chief reason for the very great difference between the new districts of German towns and those of our towns is, that German municipal authorities, in common, so far as the Author can learn, with those of every other civilised country except our own and perhaps the United States, have the power to control the growth of their towns by making town extension plans, the arrangements indicated on which must be complied with by all owners of the land which is within the boundaries of the town, and by all who build on it. In Prussia the power was formally given by a law, passed in July 1875, known as the Street-Lines and Building-Lines Act, but the power had been exercised for a long time before that Act was passed. Till the Napoleonic wars all the principal Continental towns were surrounded by fortifications, and most of their streets were extremely narrow. When fortifications could be got rid of by many of the towns, the desire for more air and light found expression in the creation of very wide new streets. Expression could be given to this desire more easily in Germany than would have been the case here, had our towns been suddenly relieved of encircling walls, because a large proportion of German towns were the residences of Sovereigns, Reigning Grand-Dukes, who, directly or indirectly, governed the towns. These rulers desired to have imposingly wide streets round and near their palaces, and there was a good deal of emulation among them which led each to wish that his town should be more impressive than the towns of his brother rulers. Hence, during the earlier and middle parts of the last century very wide streets and abundant planted open spaces became the rule in the new parts of German towns. With the rise of manufactures, however, towns, which were not the seats of rulers, began to increase in size rapidly; and, as in them the same temptations existed, which have so strongly influenced the growth of our manufacturing towns, to make narrow streets and not to provide open spaces, it became necessary to give all municipal authorities statutory powers to control the width and direction of streets, and the supply of open spaces and of vegetation. The Author gives here a few passages from the Prussian Street-Lines and Building-Lines Act of 1875 as an example of the laws conferring similar powers, which are in force in all parts of Germany.

"The street-lines and building-lines for the making and alteration of streets and squares in towns and country places

are to be fixed in accordance with public needs, by the executive part of the municipal government in conjunction with the community, or the elected members of the town council, subject to the agreement of the local police authority. The local police authority can demand the fixing of such lines, if this be needed for police reasons, of which the police authority is to judge."

"Lines can be fixed for single streets or parts of streets, or, to meet the foreseen needs of the near future, can be laid down, by means of building plans, for larger areas."

"In deciding on the lines regard must be had to the protection of traffic, safety from fire, and the public health, and care must be taken that streets and squares be not disfigured. Care must therefore be taken that adequate width be given to streets and that new building areas be well connected with those already existing."

It is those few words, "Lines can be laid down for single streets or parts of streets, or to meet the foreseen needs of the near future can be laid down by means of building plans (Bebauungsplaene) for larger areas," which give German municipal authorities the power to save their people from the degradation which our suburban districts are bringing on ours. The words have received a very large interpretation. The foreseen needs of the near future are taken by the most enlightened authorities to mean the needs of the next twenty or thirty years, and hence building plans are sometimes made for very large areas. A few years ago, the municipal authority of Dusseldorf published a plan for an area of nine square miles. The words are held by most authorities not only to give them the power to decide what streets shall be made, what shall be the width and direction of each, what squares, small planted open spaces, playgrounds, and parks shall be provided, but also to give them the power to create different "zones" or districts—districts for dwellings, districts for manufactures—each with building regulations differing from those of other districts. This power has been largely used, and with extremely good results. The words cited give power not only to reserve certain districts for dwellings, but, too, to ordain that in one dwellings-district, over which perhaps the prevalent wind passes in reaching the central districts, and in which, therefore, it is desirable that there shall be much open space and vegetation, the buildings shall not have

more than two or three storeys, shall all be detached or semi-detached, and shall not cover more than a small proportion of the building plots, while in other dwellings-districts four or five storeys may be built, a larger proportion of each plot of land may be covered, and houses may be built in continuous rows.

The building plan is generally prepared by officials who have received the training of surveyors and whose experience gives them some knowledge of engineering, and of the tasks of the architect; and sometimes by private engineers, surveyors, or architects. These persons always, the Author believes, work under the supervision, or with the co-operation, of a committee consisting of men cognisant of the various interests which have to be taken into account. It was recently stated by a representative of one of the large German towns, that no town of any importance fails to submit its building plan for revision to one of some six or eight well-known men who have acquired a high reputation for their skill in preparing plans which make new districts wholesome, convenient, and beautiful. A very large number of valuable books on the preparation of such plans have been published, of which "Staedt-Erweiterungen" von R. Baumeister, Berlin, Ernst and Korn, 1878, price 8*s*.; "Der Staedtebau nach seinen kuenstlerischen Grundsaetzen" von Camillo Sitte, Wien, Carl Graeser; and "Die Aufstellung und Durchfuehrung von amtlichen Bebauungsplaenen" von A. Abendroth, Berlin, Carl Heymann, 1905, price 3*s*., are perhaps the most useful for English readers.* Sitte's book, which is regarded as epoch-making, gives much attention to the principles, by observance of which towns are made beautiful. Abendroth's book describes the whole procedure involved in the preparation of a plan. There is an excellent monthly magazine, "Der Staedtebau," published by Ernst Wasmuth, Berlin, which is devoted to the consideration of the subject of the extension and alteration of towns.

Land is held by far more persons in Germany than in this country; the plots held by many persons are small, and many

* The second edition of a very comprehensive, well-illustrated, and in every way valuable book on the construction of towns, by Dr. J. Stuebben, one of the highest German authorities on town-planning, has just been published by Alfred Kroener, Stuttgart. It forms the fourth part of a monumental Handbuch der Architektur. The title is "Entwerfen, Anlage und Einrichtung der Gebaeude," and the gross price of the volume is 85*s*.

of the plots have been strips of a few furrows in width, which have been left by farmers to their children. These plots, being very long and narrow, cannot be used separately as sites for buildings, and, therefore, when a building plan is published by a municipal authority, many sales or exchanges of property are needed before building can take place. In order to quicken this difficult process, Dr. Adickes, the Oberbuergermeister of Frankfurt-a-M., obtained the passing of a law, known as the Lex Adickes, which was at first intended for the whole of the Prussian kingdom, but was eventually restricted in its application to the town of Frankfurt. It enables the town council to expropriate all the land in a new urban district, temporarily, to deduct from the whole the land needed for streets and open spaces, and finally to redistribute the residue among the original holders in plots of shapes suitable for building purposes, each owner contributing land for public purposes in proportion to the value or the area of his original holding.

The Prussian Lines Act of 1875, and many of the similar laws in use in the other German countries, were passed at a time when the problems created by the rapid growth of towns seemed less important than they have proved to be, and when they had not received the careful study which has since been given to them. The existing laws do not, therefore, give municipal authorities all the powers which they need for the purpose of making towns as wholesome as possible. German towns suffer far more than ours do from high rents and from the inevitable result of high rents, overcrowding of dwellings. And while the evil of overcrowding in this country is felt, as a rule, only by the poorest class, in Germany a large number of persons of the middle class are compelled by the dearness of houses, to occupy inconveniently small dwellings. To enable municipal authorities to remove or mitigate these evils, the governments of Hessen and Saxony have passed Housing Laws in the last few years which have already lessened the evil of overcrowding in some parts of those two countries.* The Prussian Government published the draft of a Housing Bill two years ago which is intended to make good some of the deficiencies of the Lines Act of 1875. The Author will indicate very briefly some of the changes which it is proposed to make by the

* Some of the provisions of the Hessian and Saxon Acts are given in "The Example of Germany," by T. C. Horsfall, Sherratt and Hughes, price 1s.

Bill, but, before doing so, he must explain how it is that there is so much overcrowding in German towns. The elected part of a German town council is, in all parts of Prussia except the province of Hanover, the districts of Sigmaringen, Stralsund, and Schleswig, and the city of Frankfurt-on-the-Main, elected by a most undemocratic method known as "the three classes system." By this method the ratepayers who pay one-third of the rates and taxes in the largest amounts, have the right to elect one-third of the whole number of elected members of the town council, those ratepayers who pay the second third in the next largest amounts, elect another third of the elected members, and all the other ratepayers, whose contributions make up the remaining third of the rates and taxes, elect the other third of the members of the town council. The system gives nearly all voting power to the largest ratepayers, and reduces each of the voters of the third class to a close approximation to insignificance. The Berlin figures will prove this. There, less than one-third of 1 per cent. of the total number of municipal voters have the right to elect one-third of the members of the town council, and 3 per cent. of the total number of voters control the election of two-thirds of the members of the council. But this is not all. Half the members of each town council must be house owners. Hence the interests and supposed interests of rich people in German towns are very safe from attack. And, unfortunately for the working classes in those towns, it is to the pecuniary interest of many persons that the price of land shall be high, and that rents shall also be high. For, as has already been mentioned, when the towns were freed from their encircling walls and forts, the new streets in many towns were made very wide, and as, if small houses were built on each side of a very wide paved street, the rents would have to be extremely high to cover interest on both the cost of the building, its site, and the land to the middle of the street, houses of five and six storeys were built. Another mistake also was made: too great distances were left between the streets, and consequently each building-site was very large, and the tall house standing by the street did not cover enough of it to enable moderate rents to pay interest. So blocks of tall buildings were added behind those standing by the streets. As these buildings were so tall, they had to be solidly built; and the cost of the expensive structure and of the land in the street and site,

even when distributed over many dwellings, made it necessary to charge high rents. Moreover the great size of the houses, indicated by the fact that in Berlin the average number of inhabitants is 52·6 per house, and in Breslau 35·4, makes it impossible for any one who cannot command a good deal of capital or credit to build, and makes the supply of new houses much less abundant than it is in this country, where a house can be built for less than £200. High rents for dwellings and high prices for land having been thus created, it is to the interest of every house-owner and every owner of land that no change shall be made in the arrangement of new streets, and in building regulations, which will lower rents and prices of land; and at least some members of the elected part of a German town council are obviously fit instruments for the defence of the interest of the owners of both kinds of property. Happily, a considerable number of men of high character and great intelligence are elected, and these and many of the members of the executive portion of the municipal authority strive hard to protect the interests of the whole community, and especially those of the poorest classes. The Oberbuergermeister and Buergermeister of a German town, and a number of men called Beigeordneten, who do the kind of work which in this country is done by the chairman of committees of a town council, are all paid salaries, and are elected by the elected members of the town councils, in Prussia for periods of twelve years; in some other German countries for nine, and in others for six years. At the end of the first or any later period of office, the Buergermeister and the Beigeordneten can be re-elected or not, as the town council decides; but if it fails to re-elect one of them, it has to pay him a pension, the amount of which varies according to the length of time for which he has served. These men, knowing that if they are efficient, courteous to their colleagues, and of good behaviour, they will probably remain in office as long as they wish to do so, have time and every motive to seek to advance the interests of the town in all possible ways. It is under their superintendence that the admirable building plans, which have been mentioned, are prepared and all the other work of the authority carried on, and from them come many of the most valuable suggestions for reform.

To return now from this digression to the proposals of the new Prussian Housing Bill, which embodies many of the

suggestions made by members of the executive portion of the municipal authorities.

The Bill states that consideration for the need for dwellings must be added to the considerations to which regard must be had in fixing street and building lines; that care must be taken that there be provided open spaces, abundant in number and in size (also town-gardens, play-grounds, and recreation-grounds), building sites of suitable depth for dwelling purposes corresponding to the varied need for dwellings, also that streets of less width shall be made, and that building land corresponding to the need for dwellings shall be opened out by the fixing of lines.

Some town councils have felt doubt as to whether the Lines Act of 1875 gives them power to create separate building districts or zones, each with its own building regulations, and as the Prussian Government is convinced that this should be done, the Bill states: "By Building Bye-Laws can be regulated:—

"1. The graduating by districts, streets, and squares of the extent to which sites shall be covered with buildings;

"2. The separation of particular districts, streets, and squares in which the erection will not be allowed of buildings which are likely, in working, to cause the neighbouring inhabitants or the public, danger, injury, or annoyance, by diffusing bad smells, thick smoke, or unusual noise;

"3. The plastering, painting, or pointing of buildings mainly serving as dwellings, and of all buildings situated on streets and squares;

"4. Proceedings against buildings which disfigure the streets or public places in towns or in country places."

Germany has a most difficult housing problem to deal with in its large towns, where tall, dear, and therefore overcrowded, houses are very numerous; but even in those towns in new districts the evils caused by overcrowding are partly compensated for by the good influence of the pleasant and wholesome environment of the houses; and the life of the working classes there is certainly much fuller and brighter than that of the inhabitants of our new urban districts. In those new districts of German towns, where the houses are comparatively small, the combination of wholesome dwellings and wholesome environment gives results far superior to any obtained in English towns controlled by town councils, though they are equalled, and

perhaps surpassed, by the results obtained in England in Bournville, Port Sunlight, and Mr. Rowntree's village near York. If English towns would adopt the best kind of German town-planning, and retain good English types of houses, their new districts would probably be the most wholesome urban districts in the world. And when we had wholesome new suburban districts, in which to house families removed from the slums, we could then attack the old slums, and eventually obtain towns wholesome both in their new and their old districts.

The German Governments, and, the Author thinks, all German students of the housing problem, know that towns cannot be brought into, and kept in, a condition which shall make it possible for human beings to have good health, physical, mental, and moral, in them solely by means of town building plans, and of the building regulations which form part of such plans. They believe that town councils must own much land, and for this purpose must have the right to buy it whenever they can get it as private persons may; they are convinced that every house containing small dwellings, and the servants' and apprentices' rooms in large houses, must be carefully inspected at not very long intervals of time; that co-operative and other societies must be encouraged to build wholesome small dwellings by being provided, by direct or indirect aid from Government, with loans of money at low rates of interest, and that town councils must be enabled to obtain a considerable proportion of the money needed, to defray the cost of making towns habitable from the persons who now gain most by the growth of towns, by being empowered to rate land on its selling value, and levy rates on unearned increment.* Legislation for the attainment of all these objects has been already passed by several Governments, and is promised in the near future by the others.† But while the importance of all these other things is admitted by all German social reformers, they all know that the supremely important thing is

* Two hundred and sixty German towns, large and small, now rate land on its market value, nine tax "unearned increment," and about fifty others are preparing to do so.

† An interesting account of the reforms needed for the improvement of suburban districts is given in "Neue Aufgaben in der Bauordnungs und Ansiedlungsfrage, Eine Eingabe des Deutschen Vereins fuer Wohnungsreform," Goettingen, Vandenhoeck & Ruprecht, 1906. Price 1*s*.

the building plan. In all lists of the measures needed to ensure that towns shall be made less dangerous to health and strength than they now are, the improvement of the building plan and its necessary concomitant, building regulations, has the first place No one connected with a German town, rich land owner, or poor landless tenant, doubts that it is necessary for his welfare that such plans shall exist. In Professor Baumeister's book on the enlargement of towns, the English towns are mentioned as the only modern examples known to him of the monstrosity, towns built without any plan at all. It is to be hoped that our towns will soon cease to have this evil distinction.

DISCUSSION.

The CHAIRMAN: We have listened to one of the most interesting papers, with the addition of these very useful lantern pictures, which has come before the Association for a very long time. The paper is one which opens up a field to us which is almost inconceivable in the matter of dealing with land powers existing in Germany, powers which certainly do not exist here, and which we can hardly anticipate coming into effect in our time. In this country it practically lies with the landowner how he will lay his land out. He works independently of the adjoining landowner, with the result that they may make streets which deliberately miss instead of forming a direct line. I have known cases where it was as bad as that, and streets were purposoly laid out to miss each other. The question of cost is one which cannot be lost sight of. We hear of these immensely wide streets for public purposes, but we have not been told where the cost comes from. The owners of the land who have to give up possession are given back something which Mr. Horsfall tells us is equivalent to what they surrender. But there still exists a very large area which is absorbed by these streets, the value of which comes apparently out of public funds. Mr. Horsfall has spoken often of wide streets, but until almost his last word he did not give us an idea of what he considers a wide street. Doubtless Mr. Horsfall knows in this country the usual minimum required by the building bye-laws is 36 feet, and in London the Building Act requires a minimum of 40 feet. As a compliment to the

Author, and a mark of appreciation of his paper, I propose a very hearty vote of thanks be accorded to him.

Mr. A. H. Campbell: I rise with a good deal of pleasure to second the vote of thanks. I was glad to see Mr. Horsfall laid such stress on the planting of trees. I think trees do more than anything in a simple and inexpensive way to break down that dreadful monotony of bricks and mortar, which is such a nightmare to many of us. It is unfortunate that the Public Health Act of 1875, and all the amending Acts, have not conferred upon the local authorities power to charge for the planting of trees as an improvement work. Another matter Mr. Horsfall has spoken of is the better intercommunication of roads which link up different districts. I suppose nowhere, except round London, is there such a variety of separate local governing authorities—in all some 40 or 50—each separate from and with no power over each other, and with their boundaries overlapping. It is difficult to get proper inter-communication through such a maze of authorities. I hope the next Public Health Act will include some compulsory clause which will give local authorities some measure of control, so that that will be accomplished. Many landowners we have to deal with do help us, and in my own district, with the help of public-spirited men, we have been able to lay out many arterial lines of highways. Although we have heard to-night a good deal about the enterprise of Germany, yet even in Great Britain we have evidence of progress on similar lines, although perhaps not applicable to the service of districts which are inhabited by the artisan and labouring classes. Personally, I think the new town of Edinburgh, laid out 70 or 80 years ago by Mr. Playfair, is a fine example of this. Many of our sea-coast towns—Hove, for instance—are the best examples of laying out on progressive and advanced lines in this country. Then we have Bournville and Port Sunlight, but these are philanthropic experiments, and cannot be considered where philanthropy does not apply. In Germany, if they have not got a good public spirit behind them, they have certainly a most autocratic set of officials, and I am not certain whether this is not the secret of the success of the efforts of which Mr. Horsfall has spoken.

The vote of thanks was unanimously accorded.

The Mayor of Battersea: I have been very much interested

in the address, which has taught us many lessons of what can be done if the people of a country or district determine to work on the right lines. Unfortunately in London we have too many authorities. We are divided up into twenty-eight districts, and we are centrally governed by one Board, whose powers are somewhat limited. I think it would be better if we had a little less of those bodies, and one central body with greater powers, in order that we might work on the lines suggested by Mr. Horsfall in his address. We are somewhat better off than Germany in the matter of representation. We do allow more freedom to our people. In Germany it is almost impossible to get anything like democratic representation. I do not suppose for one moment the Meeting will agree with me, but I consider the whole moral of the address to be state ownership of land for the carrying out of this movement of town planning. I quite agree with Mr. Campbell that trees in the roads are an absolute necessity. In Battersea we have a small estate, and one of the first things we considered in its laying out was the provision of trees. We have many streets with trees planted on both sides, and we shall extend that every year. We recognise trees are necessary, not only from the point of beauty but of health. Unfortunately our powers are limited. We have to satisfy another body superior to ourselves. I hold that the Acts we work under in London should be consolidated, and the districts and streets should be laid out, not for the interests of the few, but for the interests of the people who will occupy the land. In that respect I may not be democratic, but we have absolute proof, in the example of Germany, that we should work on those lines. Our first difficulty is in acquiring land, and the next is to convince the people to whom we supply our plans that our plans are the right ones.

Alderman THOMPSON, Richmond, Chairman of the National Housing Reform Council: I have heard my friend, Mr. Horsfall, speak a good many times on this subject, and whenever he speaks he throws new light on it. The real authorities we have to convince are the practical men who will advise the Councils. For that reason the Housing Reform Council has requested Mr. Horsfall, and he has kindly consented to give his time and abilities to placing the matter before those who are entrusted with the control and development of our towns. Then we have had deputations to the Prime Minister and

the President of the Local Government Board. They said the whole of our proposals were full and fair and reasonable, and I venture to say the proposals Mr. Horsfall has put forward to-night are fair and reasonable. We urge very strongly that there should be a central authority with very complete power over land, housing and transit—those three things being so intimately connected. I believe we shall get power to control the lines of main roads. If we get nothing but that it will be a very great thing to obtain in the Public Health and Housing Bill of next year. It is important that the men who will have to administer these Acts should make up their minds as to what they can ask for. We could ask for powers over main roads, which I believe we should get, and then we might go further and have reserve plots for churches, for houses for the working classes, and for public buildings. The main roads are what we can all agree upon, but we can reserve the other matters for further consideration. From what I have seen and know of local authorities, I think most of them will agree that those powers should be given. Sir Henry Campbell-Bannerman told the deputation there are two extremes—the one advocated by the Mayor of Battersea that there should be general powers to buy all the land, and the other extreme is that there should be no power to buy land unless it is immediately required. Between these two there is a middle course to be taken, which will empower local authorities to buy land for future development. If the local authorities have power over transit they will be able to indicate where land will be most valuable. I can only call your attention to Brentford, where it is proposed to spend half a million of money to widen one street. If there had been a building plan at Brentford only ten years ago it would have saved a quarter of a million. Then look at Richmond. When I went to Richmond land was changing hands at hundreds where we now have to spend thousands of pounds. Land which formerly was worth £600 per acre is now worth £6000 per acre. I hope you will agree upon some practical proposals to place before the Government, and to get the thin end of the wedge in, so that we may have some general town plan agreed to by the authorities, and that there shall be certain powers given to them for purchasing a certain portion of land. I would suggest that we should adopt the German plan for dealing

with the land, and the English plan for dealing with the buildings.

Councillor ANDOVER, Paddington: I thoroughly endorse what the previous speakers have said. As Chairman of a Public Health Committee, I shall be only too delighted if we can develop our streets with trees. If it can be done in Germany I do not see why it should not be done here.

Mr. C. H. W. Biggs: I am far too much of a cynic to believe that if we were to try Parliament and the Government we should get one-half of the things which have been hinted at to-night. Let us be very modest. One of the broad lessons that the recent Commission on the traffic in London has taught is that we have allowed streets in the suburbs of London to be made in a higgledy-piggledy fashion, with no plan from beginning to end. We have no chance of following Germany. We must take our towns, streets, and buildings as they are. There is an average of five to six persons per house in England, and from thirty-five to fifty in the towns of Germany. If our houses are to be large caravanserai, housing a huge population, then we must follow Germany. But is that possible or desirable? If we have a rearrangement of the streets which radiate in every direction, we can get rid of a good deal of the congestion which exists. I will give you an idea of what might be done and has not been done. The population of London in 1700 was about 550,000; in 1800 it had increased to about a million and a quarter. Since then it has increased enormously, and probably during the last century a million houses were built in and around London. And there was not in the whole of those building operations one predominant plan for the whole of London. Take the main roads. There has not been a new one made for the whole century. The relief which has come is from private enterprise—from railways and not street traffic. Take Germany, Cologne, Frankfurt; these towns were not large towns fifty or sixty years ago. They were surrounded by ramparts. The ramparts have been knocked down, leaving a huge circle of land which has been laid out in streets, radiating from the centre outwards. What I wanted to hear was a definite proposal, which may be handed to the Local Government Board or Parliament, showing that we have definite ideas that towns should be extended according to plans, and that, so far as the main thoroughfares are concerned, those main thoroughfares should be determined and pre-determined at all costs.

Mr. F. R. Durham, Westminster: I stand here this evening in perhaps an unique position, because I have twelve years on the Continent at my back, having spent my time in Frankfurt, and in the municipal service of other cities. I should like to take some of the points Mr. Horsfall has mentioned and answer them. The Author has spoken from an optimistic point of view, but there is another, viz. municipal extravagance. In the beginning of his paper, Mr. Horsfall referred to the development of the suburbs, he is quite right in saying that German towns are not developing in suburbs. Frankfurt, for instance, thirteen years ago, was a city of 180,000 people; it is now a city of 350,000. What does that growth mean but the incorporation of the surrounding suburbs? Hanover, Leipzig, and Cologne show the same rapid development. Then, again, the Author is very hard on the British working man, and the lack of family life and happiness. I have had a good experience of the German working men, and I have noticed that the British working man's life here has in many ways more happiness. Germany is the land of discontent of the working classes, the home of social democracy. Notable confirmation of this was given to me by a German friend who had come over to study the social and housing questions of British workmen. He had come over prejudiced against everything English, but after three months he returned and said "everything is quite different to what I expected. We are sixty years behind England in the treatment of working men, hygiene and everything else." It may be of interest to state that many of the principles quoted as coming from Germany, originated in England.. In 1842, the year of the wakening of Germany to hygiene, a very disastrous fire occurred in Hamburg, and an English engineer, Mr. Lindley, who was there on railway work, successfully assisted the authorities in subduing the conflagration. He was afterwards called in to sewer, water, and re-plan the burnt portion of the city. He laid it out on the broad principles on which towns should be laid out, with wide streets and open spaces. These principles have been copied in other towns. Mr. Lindley advised Frankfurt, Düsseldorf, and other towns; so really these ideas of town planning were brought from England to Germany, but have been developed to a fine art by the characteristic thoroughness of the German nation.

The whole construction of the municipal bodies in Germany

is different from that in this country. A correct comparison of the Continent and English municipal bodies might be made in reference to the British Parliament. The Premier might be compared to the Mayor, and the Cabinet to his Councillors, and the Town Council to the Members of Parliament. In this municipal Cabinet the municipal Engineer is usually elected, and takes part in the technical discussions. All projects and plans, whether administrative, financial, or technical, as a rule originate in the municipal Cabinet, and are sent to the Town Council for acceptance, it being unusual for the Town Council to make proposals to the Cabinet. The Mayor does not preside over the Council; a speaker elected from the body of the Town Council takes the chair. The Mayor and his Cabinet sit on one side together, and each Cabinet Member represents his particular duties, finance, education, administration, etc.

The Author has referred to the laws of Dr. Adickes, of Frankfurt. Those laws were passed about 1900, and have now been working about five years. The system on which these laws act is the consolidation of plots, and the redistribution in accordance with the proposed alignment. They thus avoid all awkwardly shaped plots, and the landowners as well as the municipal authorities benefit. In Frankfurt, in order to facilitate the actual working of those laws, the municipality, through the Mayor, generally buys up property to a great extent gradually in order to be one of the largest proprietors prior to the development, so that when the time for development was ripe, it was the town of Frankfurt that had the principal voice in the redistribution.

It must be remembered that Germany is a military nation, accustomed to obey orders, and thoroughly autocratic in its Government, and it is here that the judiciously administered autocracy comes in and forces the other landowners to come to terms. There is no doubt this law has worked very satisfactorily, and there is a likelihood that it will become law throughout Germany. Another point of difference in the working of a German municipality may well be mentioned. In the large cities, and even to towns of about 10,000 inhabitants, there is a department, not exactly the British surveyor's department, but another department which is solely responsible for the town plans, carrying out work of a somewhat similar nature to the ordnance survey. That ordnance survey

department is responsible for the careful planning and all the levels, so that it will be very difficult to find a German town of even 10,000 inhabitants which has not a complete plan, with all the horizontal curves, roads, streets, and open spaces marked out for future developments, in order that the drainage engineer (who is also responsible to a large extent in the laying out of the cities) can design the complete plan of sewers, and determine the main lines for years in advance, and provide for all future requirements of grade, storm outlets, etc. I hope to have the opportunity of meeting the Association again, and thank the members for their kind attention, and the Author for his most interesting paper.

Dr. LYON (London): A year ago I threw out a suggestion, which received considerable support, as to how we should proceed in improving London from the hygienic point of view. I will tell you in two words what happens now. A zone of houses is built near the country. There is plenty of land outside. Then another zone of houses is built outside that, and makes the first zone uninhabitable. They become a collection of dwelling-places in which it is not fit that the human child should be born and brought up. The remedy seems pretty simple, and I have never heard any one say a word against it. A fund should be formed for providing open spaces and proper streets, and every house, when it is built, should subscribe towards that fund. We shall never have the cut-and-dried system of Germany; we do not want it. What is wanted is that the municipalities of London should have a fund so that they may be in a position to say where there should be a park, and make arrangements for wide streets, and compensate the owners of the land from the fund, and this fund should be sufficient for the purpose. It would be easy to find out how much the fine should be upon each house when built to make the district a place of decent habitation.

Mr. J. LEMON: I have been very much impressed with the speech of Mr. Durham. I have visited Germany, and I must say there is a good deal to learn from that country. The town of Hamburg, with its wide streets and open spaces, is a town of very fine appearance. I cannot say I was very much impressed with Berlin. Certainly the Unter den Linden is one of the finest streets in Europe; but the Frederichstrasse is not a very wide street. But you must not have wide streets at the sacrifice

of the health of the inhabitants. There are a lot of extraordinary facts in the paper which confirm my view of what I saw when in Berlin. I wanted to know where the working men lived, and some large houses were pointed out to me, five or six storeys high. I do not want to use hard terms about them. Some people in this country would call them rabbit hutches. They were certainly very much overcrowded. I formed the opinion that German towns suffered more than English towns from high rents and overcrowding. I think I may say, without having any statistics to guide me, there is more overcrowding in the city of Berlin than in London.

Mr. HORSFALL: There is certainly much more overcrowding in Berlin than in London.

Mr. LEMON: You confirm it. When you hear of an average of fifty-one persons to a house, I do not think our English ideas will agree with that. Some controlling influence is necessary in order that our main roads and arteries should be laid out in a proper plan. If you are to have that you must give up some of your parochial ideas,—I use the words "parochial ideas" advisedly—and consent to some form of centralisation. I know that does not go down with certain people. Nothing offends local bodies so much as a controlling authority. I had the honour to serve six years on the County Council of Hampshire, and it was enabled to do a good deal of useful work. They have the power to regulate main roads throughout the county. They ought to have greater powers in the laying-out and controlling of new streets. They already have the power to control existing streets. That would not require a great deal of legislation to bring about. The landlords are not quite such a bad lot as some people think they are. Where a landowner has the control of a large area of land, there are many instances in this country where he has laid it out to great advantage. Go to Folkestone, a beautifully laid out town; go to Eastbourne, controlled by the Duke of Devonshire; go to Newcastle; and there are many other instances. Where the owner has control of a large estate, he invariably sees it is to his interest to lay it out with good wide roads. I have had to lay out a good many estates, and that is the invariable practice I have acted upon. It is to the interest of the large landowner to do that; and it is in the interest of the community.

Mr. A. GLADWELL: One cannot but be struck by the

illustrations put upon the screen, but they seem to my mind to indicate an absence of control over one's land which is amazing to an Englishman. If a man buys a piece of land in England he likes to feel that he controls it. If we are to control the operation of building developments in the suburbs of existing towns, we must have some such power as has been indicated. I was wondering, when the Author was speaking, whether, without the introduction and passing of a special Act of Parliament, or the consolidation of existing Acts, the old Enclosure Act could not be extended to meet the case. If we were to take any specific area of land in particular localities, then there are numerous owners of land who could be brought within the provisions of the Enclosure Act, and the Commissioners appointed to re-allocate and redistribute the various areas of land could (under the powers reserved to them) reserve for public purposes such land as would be required under a comprehensive and intelligible plan. Another thought struck me also. Amid all this comprehensive scheme of redistribution of areas, where would our building bye-laws come in? Recently there has been an attempt to discredit existing building bye-laws, and some hard things have been said about local authorities, the incompetence of their officials, the viciousness of the average building surveyor, etc. If we are to submit to this radical interference with our land, does it not follow that we should have to submit to similar strict supervision over our buildings? There has been, as we all know, an agitation having for its object the extinguishing of all building bye-laws, and the abandonment of all control over buildings. In fact, to let every man please himself. But I fear such would be disastrous in practice. If we are to experience this consummation in England, it may be that we must have larger areas of control. Something has been said about County Councils. County Councils may have their admirers; I am not among them. The less we centralise control, and the more locally we spend the money, the better it will be. County Councils, as at present constituted, can do nothing for local authorities that local authorities cannot do very much better, and more economically for themselves.

Mr. T. C. Horsfall, in reply: I feel it to be an honour in being permitted to speak to a number of men whose opinion on this subject I know to be much more valuable than any I can form. I did not give any particulars about the width of roads

because I believe the best German authorities are convinced they have gone too far in the direction of making wide roads. Mr. Durham has misunderstood my remarks about suburbs. The movement from the centre to the suburbs has been less marked in Germany than here. That statement is made on the authority of many friends who understand German life. I do not think Mr. Durham understood to what I was referring. The most intelligent of the working people are leaving the centre, the semi-slum districts, because they find a satisfactory family life is impossible, and removing to the suburbs, where they find the same semi-slum conditions are being set up. Then Mr. Durham thinks I said the German workman is better off than the English. I said nothing of the kind. Where I have said family life is dying out is in the large towns, I have compared the German life with life in the large manufacturing towns. In Manchester, where there is not a decent place for a working man to go and spend time pleasantly with his wife and family, I have some friends—German ladies—who have worked among our poor, and for ten years had done similar work in Berlin, and they assure me that in the poorest districts there, where the overcrowding is most serious, the people have more of family life than the people have in Ancoats, and the worst districts in Liverpool.

Communicated Reply.

In the discussion which followed the reading of my paper, four questions were asked, which could not be answered at the moment—

1. It is stated in the paper that Berlin streets are very wide. What is the usual width?

2. Where the width of existing streets is increased to conform with a plan subsequently laid down by the Advisory Board of Experts, does the local authority compensate an owner for the area taken?

3. Is compensation paid to the owners for the area absorbed by extra wide boulevards on newly developed estates, which may be laid down on lines settled by the Advisory Board?

4. Does the local authority pay the cost of street formation, together with the forming and planting of shrubberies, where a large area of ground has been taken from property owners for the purpose?

I can best answer these questions by quoting the section of the Prussian Street-lines and Building-lines Act of July 2, 1875 (§ 15), which relates to the width of streets and the payment of their cost. The section is thus worded—

"It may be decided by bye-laws; in the case of the construction of a new street, or the lengthening of an already existing street, if such street be intended for building on, as well as in the case of the building on existing streets, or parts of streets, on which no building has hitherto taken place, that the clearing of the ground, the construction and the adequate draining and lighting of the street, and also the temporary maintenance of it—for at the longest five years—shall be carried out by the persons who build (Unternehmer) the new buildings, or by the owners of the land touching the street—by the latter so soon as they erect buildings on the new street—or that they shall pay a contribution for the necessary costs of all these measures. The owners of the land bordering the street cannot be burdened with these duties for more than half the width of the street, and, if the street is wider than 26 metres (28 yards, 1 foot, 3 inches), not for more than 13 metres. In calculating the costs, the cost of the whole of the construction of the street and of its maintenance respectively must be calculated together and charged to the owners in proportion to the length of their boundaries which touch the street."

The foregoing extract answers questions 3 and 4.

Question No. 2 can be answered by the quotation of another section of the same Act (§ 13), which runs—

"Compensation cannot be claimed for the restriction of freedom to build due to the regulations of § 12" (which forbids building till a street is ready for the purpose), "and compensation for deprivation or restriction of ownership of land caused by the adoption of new lines can be claimed only in the following cases:—

(1) If the areas of land destined for streets and squares are made over for public traffic at the request of the town.

(2) If the street-line or building-line touches existing buildings, and the plot of land is cleared of buildings up to the new line.

(3) If the street-line of a street which has to be constructed touches a plot of land which is not yet built on, but which has

been prepared for building on, and at the time when the new street-line is adopted, is situated on another street which is already ready for traffic and for buildings, and building takes place on the line of the new street."

The compensation, in all cases of land destined for streets and squares, is granted for withdrawal of ownership of land. Also compensation is given for the reduction of the property which has been built on in those cases under No. 2, in which a reduction of property occurs in consequence of a building-line other than the street-line being established. (§ 12 of the Law respecting the Expropriation of Property in Land of June 11, 1874.)

In all the above-mentioned cases the owner can demand that the whole plot of land shall be taken over, if the plot is entirely, or to so great an extent taken in by the line as to be, according to the Local Building Regulations, no longer fitted for building purposes.

One of the slides shown to illustrate the paper was of a typical block of Berlin barrack-dwellings. The streets surrounding the block have the following widths: one, 74 feet; two, 85 feet; one, 112 feet. These are common widths of streets in Berlin.

The regulations of the General Building Law for the Kingdom of Saxony of July 1, 1900, are regarded by many housing reformers in Germany as the best now in force. They compel owners of land to give land for streets up to a width of 28 yards, if the street is to have buildings only on one side, and up to a width of 18½ yards if there are to be buildings on both sides. A man who holds land by a new square must give land of the width of 26 yards. The principal clauses of the Saxon Act are given on pp. 51–71 of "The Example of Germany."

A hearty vote of thanks was passed to the President and Council of the Institution of Civil Engineers for the use of the rooms of the Institution for the purposes of the meeting.

HOME COUNTIES DISTRICT MEETING.

May 11, 1907.

Held at the Leopold Institute, Slough.

J. PATTEN BARBER, M.INST.C.E., PRESIDENT, *in the Chair.*

THE Members were received by the Chairman of the Slough Urban District Council (F. Parr, Esq., J.P.); the Chairman of the Eton Rural District Council (J. Hartopp-Nash, Esq., J.P.); and the Chairman of the Bucks County Council.

The President suitably acknowledged the hearty welcome given to the Association by the Chairmen of the various Local Councils.

SOME PARTICULARS OF A SMALL TOWN.

BY W. W. COOPER,

SURVEYOR TO THE URBAN DISTRICT COUNCIL OF SLOUGH.

THE comparatively modern town of Slough lies chiefly in the ancient Parish of Upton-cum-Chalvey, is situate on the main line of the Great Western Railway, and has for its neighbours the historic towns of Windsor and Eton. The name Upton is mentioned in the Doomsday Book as "Upper Town" or "Opetone," being a Manor or Tithing of Earl Harolds. The Manor was granted by William I. to Hugh de Beauchamp, whose son subsequently gave it, with a right of presentation to the Church of Upton, to the Convent of Augustiania Canons at Merton in Surrey, a monastery founded in 1121 by Gilbert Norman and Henry I.

In 1824 the place was so insignificant that there was no resident clergyman, doctor, or lawyer in the parish.

The word "Slough" is a corruption from the word "Slow," which was the name of the open land in that part of the parish called in old documents the "Slow Field," as distinguished from "Upton Field," and the "Chalvey Field."

In consequence of the making of the Great Western Railway, which was opened as far as Maidenhead on June 4, 1838, the population began to increase, and old accounts speak of the "singular healthiness of the soil and climate," and this is said to have caused the building of that part of the town known as Sussex Place and Upton Park.

Eton College long successfully opposed a railway station at Slough, but from the time this was obtained an impetus was given to building, and the name "Slough" chosen by the railway company and post office has overshadowed and obscured the older name of Upton.

That the soil of the district is well adapted to the growth of flowers, Messrs. Turners' and Veitches' large nurseries show. In former days mulberry trees and the breeding of silkworms was largely in vogue.

One of the largest buildings is the British Orphan Asylum near the station, originally Dotesio's Hotel.

In the afore-mentioned church lie the remains of the great astronomer Sir William Herschel, who resided at "Observatory House," where he made and erected his 40-feet and 20-feet telescopes, and was the means of discovering in 1781 the planet "Uranus." In 1802 he presented to the Royal Society a catalogue of 5000 nebulæ and clusters of stars he had discovered. He died in 1822.

Slough has few large industries, the chief being the well-known "Elliman's Embrocation," but will soon possess another well-known brand in that of a factory for Horlick's Malted Milk; there are also the large works of Messrs. Peters and Co., makers of railway carriage equipments.

The town possesses an excellent Drill Hall, Armoury, and Recreation Rooms, together with a well-appointed Fire Station, Hose Drying Tower, and Steamer, all of which are the generous gifts of J. Elliman, Esq. The very efficient Fire Brigade is a voluntary one.

The Great Western Railway Company provide an excellent

service of trains and motor 'buses, and the town is within 25 minutes' ride of Paddington terminus.

In submitting this paper the Author feels the disadvantages, inseparable from service in a small town, in being unable to submit anything that may possibly be new or very extensive in character, nevertheless it is hoped that its contents, together with the works to be visited, will be of interest as showing in some respect how an authority representing a small community endeavours to manage its municipal affairs with what is considered "economy and efficiency."

In 1863 the Local Government Board conferred urban powers, the area of the District then being about 430 acres, and the population about 4000. By 1899 some of the areas outside, but abutting on the urban area, had become largely populated, and were rapidly increasing. The Author, by the directions of his Council, prepared a scheme for the enlargement of the Council's urban area, which was duly submitted to the Local Government Board with an application for an "Extension Order." The proposed added areas included Upton-cum-Chalvey, parts of Stoke Poges, Farnham, and Langley-Marish parishes, all situate in the rural district council area of Eton. After protracted public inquiries by the Local Government Board, etc., and confirmation by the Bucks County Council, an order was made whereby the Council's area was increased to 1530 acres, the population included doubling that of the "old area." The new area was unsewered, the houses, mostly of the cottage class, draining to cesspools, there was no adequate system of scavenging, and the roads were for the most part unlighted. After obtaining the "Extension Order" the Author was appointed, under a special agreement and terms, engineer to prepare the necessary particulars and for carrying out the requisite main drainage system for this added area. Before giving details of the sewerage system a few general statistics may here be stated.

Present area of urban district, 1530 acres; present estimated population, 14,000; present number of houses, 3282; death-rate, 1905, 10·0 per 1000; death-rate, 1906, 10·2 per 1000; rateable value, £64,211; assessable value, £74,119.

A penny in the pound produces £254 per half-year for district rate purposes.

The urban district rate is 3*s.* 1*d.* per year; the expenditure by the several Committees being as follows:—

Highways, 10*d.* in the pound per year; drainage, 1*s.* in the pound per year; lighting and general purposes, 6*d.* in the pound per year; finance, 9*d.* in the pound per year.

The amount of present loans is as follows: sewerage, £43,579; recreation ground, £520; town depôt and office site, £4040; total, £48,139.

The subsoil is dry, consisting mostly of gravel and sand, overlaid in parts by several feet of loamy marl, locally termed "brick earth."

Excellent gravel and sand are obtained for building purposes.

The gas supply, electric light, and water are owned by separate companies.

The Author's Council obtained the Order for electric lighting in 1902, and handed over same on terms to the Slough and Datchet Electric Supply Company, reserving power to purchase at the expiration of 21 years.

The Gas Company charge £1 17*s.* 6*d.* for street lamps per year for 4 ft. burner, inclusive of lighting and extinguishing. The standards, lamps, and lights are maintained by the Council's staff, and belong to the Council.

Gas is supplied in bulk at 3*s.* 6*d.* per 1000 cubic feet, to private consumers at 3*s.* 11*d.* per 1000 cubic feet (exclusive of meter rent).

The small street lamps are lit at sunset and extinguished at midnight; the flat flame burner is being gradually superseded by the incandescent. The whole of the Council's thoroughfares are lighted.

Sewage Disposal.

Slough is a water-closeted town, and with many baths. All new house drains and sewers are subjected to the water test. It is sewered throughout on the "separate system," *i.e.* each street has two pipe conduits, one for sewage and one for rain-water from roads and houses. With the exception of some portions of the old area of Slough each house has the separate system of drainage.

The rain-water is conveyed to the nearest water courses. Upwards of 35 miles of soil and surface sewers are laid with

pipes, the sewage gravitates to the outfall at Chalvey, where it is pumped in its crude state through 1 mile of 15-inch rising main to the Council's farm, Dorney, and distributed by carriers and earthgrips over land occupying an area of 65 acres, the subsoil being of an excellent porous earth and loamy gravel.

The farm is in charge of the Author, and the sewage is distributed by the Council's staff. The sixteen sewage bays, when at liberty, are let to the Council's tenant, who has the remainder of the farm (300 acres) not used for sewage purposes. There is no effluent, and the land is not sewage sick. Twenty-five acres are the Council's freehold, and the remainder of the farm is held on lease.

The sludge which accumulates in the outfall receiving tanks is pumped by a centrifugal pump, 6-inch suction, through a separate 9-inch rising main, and deposited on separate bays.

The Author, in preparing the main drainage scheme for the added area, provided for the laying down of about 12 miles of sewage and rainwater sewers in stoneware pipes, with three Shone ejector stations, air and delivery mains, air-compressor plant, and also for the laying out of 40 acres additional land. The sewers consisted of 15-inch, 12-inch, 9-inch, and 6-inch Hassell's double and single lined, cement-jointed pipes; all sewers when laid were put under the water test and laid and cradled in concrete. The greatest depth of sewers was 21 feet, and the average 14 feet. A length of 15-inch iron pipe was laid in tunnel under the Great Western Railway main line. A large quantity of ground water was met with, but the work was so well done that at completion practically no ingress of water was found at the outfalls. The dead ends of sewers, together with other points, have 6-inch ventilating shafts, 25 feet in height, and manholes provided with flushing discs. All sewers are flushed at least once a month by carts.

The three Shone ejector stations have fifty gallon receivers in duplicate discharging into the nearest sewer, and are situate within 1¼ miles of engine air-compressors. The greatest lift is 30 feet and the least 8 feet.

The Author's estimated cost of the added area drainage scheme was £24,500, and the actual cost was the same amount, including all wayleaves and compensations. The scheme in every way meets the requirements, also the approval, of the Author's Council.

The pumping station contains—2 Tangyes' horizontal, 14-inch diameter, double-acting pumps, 24-inch stroke; 1 small donkey feed pump; 1 Tangyes' centrifugal pump (6-inch suction); 1 engine air-compressor in duplicate for ejectors; 3 Lancashire boilers worked to a pressure of 40 and 80 lbs., total grate area, 42 square feet; 1 Lyon's steam disinfector; 1 hot and cold water bath for drivers and stokers; 2 partly covered receiving tanks, capacity about 70,000 gallons.

The dry-weather flow is about three million gallons per week.

The staff consists of two drivers and two stokers worked in two shifts.

The average cost for fuel (coal slack), for all pumping, is 6*s.* 2*d.* per million gallons, with fuel at 10*s.* per ton.

Meldrum Boiler Furnaces.

Owing to the increase of pumping and consequent use of more steam, the annual coal bill was a heavy charge on the district rate. In 1904 the Author advised his Council to have affixed to the three boilers Meldrum's Boiler Furnace apparatus at a cost of £120, for the purpose of utilising as fuel some of the dustbin refuse; this, with the addition of the cheapest coal slack that can be purchased, has proved quite a financial success. The following particulars show the cost for fuel for supplying steam to all the fore-mentioned plant:—

		£	*s.*	*d.*	
1903	...	220	8	4	Previous to adoption of Meldrum furnaces.
1904	...	113	7	9	Six months' use of Meldrum furnaces.
1905	...	42	2	0	Twelve „ with „ „
1906	...	48	9	0	„ „ „ „ „

In addition to this advantage a further saving is obtained by utilising the boiler flue dust with an admixture of carbolic for dustbin disinfecting powder. The fine boiler ash is used for paving works, and the old tins and scrap are crushed by steam roller and sold.

The clinker residue is also similarly crushed and used for concrete channels and flags.

The refuse consumed is 2·6 tons per day; the quantity of coal slack is 1·42 cwt. per load of refuse. The quantity of clinker residue is about 9 cwts. per day.

Concrete Flag and Channel Making.

The Members will have the opportunity of inspecting this work. The flags are faced with Mountsorrel granite screenings, the channels are unfaced. Some 2 miles of the latter have been made and about 4000 square yards of the former, and are wearing well.

It will be noticeable to the Members that the plant and system of making is not up to date; but as the space is very limited and the Council has recently purchased a central site for a town depôt and offices, it was not thought advisable to increase the outlay for plant, etc.

The cost of making this material is below the market price for similar articles. The several works last mentioned have been so economically successful that it has enabled the Council's district rate to be gradually reduced, and many long delayed and desirable improvements have been done out of current rate instead of loans.

House Refuse Removal.

There is a weekly collection of refuse; a liberal interpretation of what is trade refuse is allowed, but trade refuse only is charged for at 3*d.* per bushel or 3*s.* 6*d.* per load.

The horses and drivers are hired and one labourer of the Council's staff accompanies each cart and books the work done.

The costs for manual and team labour for 1906 are as follows:—

Total cost, £522 4*s.* 6*d.*=about 2*d.* in the pound per year. Average number of dustbins and ashpits cleaned per load removed, 55·5. Average number of houses cleaned per day, 156·8. Average cost per house called at, 0·78 pence. Average cost per house cleaned, 0·79 pence. Average cost per load collected and removed, 3·67 shillings.

Slough Playing Fields.

These cover an area of 25 acres, and consist of a pavilion known as "The Barn," a lodge, and suites of lavatories, which have recently been handed over to the Council by the splendid generosity of J. Elliman, Esq., with an endowment of same amounting to £10,000. The Lodge and Barn are very elaborately equipped and furnished throughout.

The Council offered to the donor the services of the Author, by whom numerous plans and specifications have been prepared and assistance rendered in carrying out the several works to a successful completion. It is hoped the Members will have time to visit this site.

Roads.

The Slough High Street forms a portion of the great Bath Road, and consequently has to sustain a large quantity of traffic.

	Miles.	Yards.
Length of main roads	4	788
Length of highways	10	1132
Total ..	15	160

The inclusive costs of maintenance per mile are as follows—

Highways.

Manual labour, £53; team labour, £38; improvements and materials, £86; total per mile, £177.

Main Roads.

Manual labour, £96; team labour, £82; improvements and materials, £220; total per mile, £398.

The roadways generally are made with Clee Hill and Rowley Regis granite and the side streets with picked field flints. Granite delivered to road is 14*s.* 6*d.* per ton, and flints 9*s.* 6*d.* The Author has also laid down about 800 tons of tarmac and tar macadam in the main high street.

All Private Streets are made up under the Private Street Works Act, 1902. The Council have a standard specification, stating the minimum requirements under which they will adopt a private street. By arrangement with the Great Western Railway Co., the Company constructed an elevated railway wharf for the reception of the Council's road materials. The granite is delivered in 20-ton hopper waggons, which can be emptied into the bays within 1 minute. This wharf arrangement has many advantages: (1) Saving in cartage and labour, (2) Materials always available for use at the most convenient time, etc.

The Company charge 1*s.* per full truck for shunting to siding.

Dust Palliatives.

The Author has experimented with several of these, and has found gas-tar oil to give the best results. The Council propose to extend the experiment this season. The advantages realized are briefly as follows:—Easily applied without interfering with traffic. Drys quickly. No offensive odour. Road surface made practically impervious. No disintegration of surfaces by motors. Very little mud in winter. Less wear of surfaces. Less noise.

The material is applied by hand on granite road in good condition.

Gas tar oil 2½*d*. per gallon delivered. Total cost, first coat, 1·88 farthings per yard super. Second coat, 0·94 farthing.

One-eighth of a gallon per yard super in first coating.

SOME NOTES ON PUBLIC WORKS, WITH SPECIAL REFERENCE TO EXPERIMENTS IN ROAD SURFACE RENEWALS AND THE DESIGN AND CONSTRUCTION OF A VILLAGE SEWERAGE AND SEWAGE DISPOSAL SCHEME.

By ARTHUR GLADWELL, Engineer and Surveyor to the Rural District Council of Eton.

Foreword.

The Eton Rural District comprises an area of 43,000 acres, with a population of about 22,000, and an assessable value of £170,000; it is situate at the extreme southerly end of the county of Buckingham. The locality is rich in historical and archæological associations, a description of which would form the subject of a long and interesting article did not the exigencies of the circumstances under which this paper is written demand that only such matters shall be touched upon as immediately relate to engineering and cognate subjects.

There are nineteen parishes in the Rural District (several of which are partly urban in character), with 150 miles of district roads, some of which, as may be imagined from the proximity of the district to the Metropolitan area, are of considerable and increasing importance.

In six of the parishes of the district, the Council, by contractors, undertake the cleansing of cesspools, etc., and the removal of house refuse under an order of the Local Government Board, issued in pursuance of the provisions of Section 42 of the Public Health Act, 1875.

Experiments in Road-surface Renewals.

In the sphere of the work of a Municipal Engineer the question of road-construction takes an increasingly prominent and important place. The road engineer is now to a greater extent than heretofore confronted with the problem of how best to provide for the enormous accession of traffic which the roads of the country generally have to maintain (an increase which is certain to continue at a still greater ratio than has been the case hitherto), as well as for the altered conditions of traffic, which all tend to render the problem as imperative of solution as it is acute in character.

In considering this important question with a view to improving present methods of construction in connection with the roads under his charge, the Author has made a series of experiments, the result of which he, with all deference, submits to the impartial and critical judgment of his colleagues, in the hope that what is good in the system here suggested may be tried by others, and what of efficiency or completeness it lacks may be brought out in discussing these suggestions.

Under modern traffic conditions an urgent necessity exists for the adoption of a method of road construction which does not depend in any of its processes on (*a*) The introduction into the structure of the road of loose particles of sand, road-scrapings, etc., and (*b*) Avoids the necessity for the use of watering-carts, thus enabling surfacing work to be carried out in the summer months in country districts having no public water-supply, and where water is scarce. (*c*) Gives a waterproof covering to the road foundation. (*d*) Yields an absolute minimum of dust, thus doing away with the dust nuisance. (*e*) Enables granite or other reasonably available material to be employed at the discretion of the road engineer. (*f*) Produces a safe surface for traffic in all conditions of weather. (*g*) Can be carried out without serious inconvenience to traffic. (*h*) Does not materially increase the cost of the work as compared with the usual method.

The operation of re-surfacing a road is carried out in the following manner:—

The existing road surface (if misshapen) is brought up to proper form and cross section, and well rolled to a solid surface (this operation would be equally necessary under any other

system; in the great majority of cases, however, this need not be done). A layer $\frac{3}{4}$ inch in thickness of bituminous matrix composed of $\frac{1}{4}$-inch granite or other chippings mixed with tar, pitch, etc., is laid on the old road surface, and covered with a two-stone thickness of $1\frac{3}{4}$-inch or 2-inch broken granite or flints to form the aggregate. The aggregate being carefully and evenly laid over the matrix, it is immediately rolled down into the latter by means of a 10- or 12-ton steam-roller, the matrix, following the line of least resistance, is forced up into the interstices of the granite aggregate; the rolling is continued until the matrix appears near the surface, when it will be found of advantage to supplement the lower matrix by brushing into the surface-interstices a small quantity of similar matrix, which, however, must be made up with chippings not larger than $\frac{1}{8}$ inch gauge. The whole mass is then thoroughly well rolled, when it will be found that the finer matrix will entirely seal the surface of the road against moisture, and result in a compact traffic- and weather-resisting, as well as a practically dustless, road.

A section of road was laid down under the above system early in August last, and will be submitted to the inspection of the meeting.

No watering-carts or sweepers will be found necessary, so that the cost of these will be a set-off against the extra cost of the bituminous matrix. It is the Author's intention to bring up details of the cost of this process, fully analysed; these will be communicated in writing, and will include the cost of the work which will be in progress on the day of the meeting. In town work carried out under this system it might be of advantage to give a tar dressing to the finished surface after the lapse of, say two or three months, and renew this treatment annually.

The Design and Construction of a Village Drainage Scheme.

As has already been mentioned, the Local Government Board have placed upon the Council an order under the provisions of section 42 of the Public Health Act, 1875, in respect of scavenging, etc., in six parishes, viz. Burnham, Iver, Langley Marish, Datchet, Horton, and Fulmer. The work is now being

carried out by contractors, but in respect of the parishes of Burnham and Iver, the Council decided to supersede this system by providing drainage schemes. The Author was therefore instructed to prepare details of these schemes. The scheme for dealing with the sewerage of the urban portion of the parish of Burnham (the one herein described) is now approaching completion; that for Iver has been delayed owing to difficulties which have arisen in connection with the acquisition of land necessary for sewage disposal works.

The Burnham scheme is designed to deal with the sewage from a population of 4500 persons at the rate of 20 gallons per head per diem; this sewage is delivered on the works by gravitation through a system of about 4¼ miles of 15-inch, 12-inch, and 9-inch stoneware sewers, and flows from the outfall sewer to three detritus or grit chambers, which are provided with sharply sloping floors for convenience of the removal of detritus by means of sludge valves and pipes which can be brought readily into operation. The sewage then flows to a distributing channel which runs at the back of the three liquefying tanks, and is connected thereto by means of six 9-inch cast-iron submerged inlets regulated by disc valves. The liquefying tanks are 45 feet by 15 feet by 6 feet 6 inches average (excluding sludge pits) depth, and have sloping floors for the more convenient removal of sludge, which can be valved off to sludge lagoons; the tanks are covered with a flat ferro-concrete roof sufficiently ventilated, and are calculated on the basis of a capacity of twenty-four hours' dry-weather flow.

The tank effluent flows under double scum boards and over a stone weir at the outlet end into a distributing channel and thence through ports (which are fitted with automatic cut-offs and recorders) to three measuring chambers, each having a liquid capacity of 750 gallons, the contents of the measuring chambers are held up by means of automatic valves until the above capacity is reached, when discharge takes place; the effluent being conveyed by means of 6-inch cast-iron pipes to automatic revolving open-trough distributors each 53 feet diameter, which spray the effluent over circular beds (having 12-inch concrete sloping floors) of graded furnace clinker, the external walls being built with dry clinker of large size.

At the present time only two beds have been constructed,

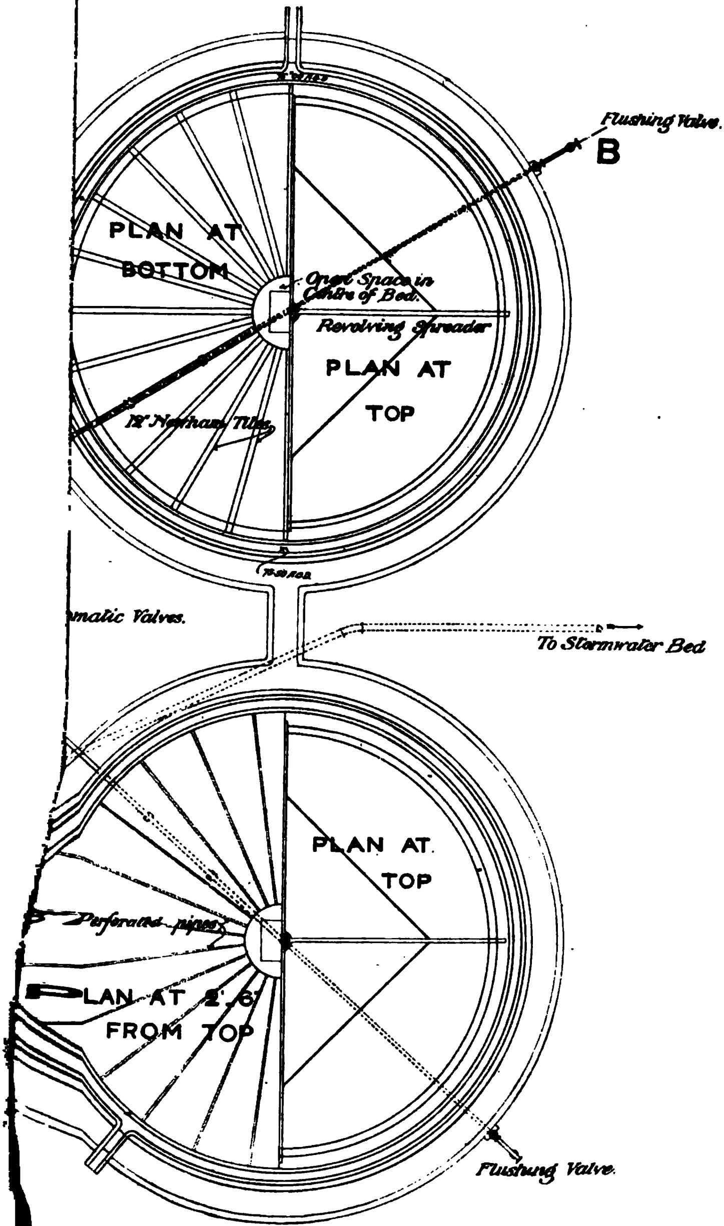
leaving the third bed to be laid down when the expected increase of population renders it necessary.

These beds are ventilated by means of radiating rows (twenty-four in number) of Newham floor tiles, which also serve as outlets for the bed effluent; the beds are 5 feet high, and are provided with twenty-four rows of 3-inch perforated stoneware pipes at half the height of each bed, with a view to assisting the aeration in the centre of the beds; in addition to this there is an annular space, 9 feet diameter left in the centre of each bed, also with a view to effecting satisfactory aeration. The capacity of the beds is calculated on the basis of dealing with 168 gallons per cubic yard per day of twenty-four hours. The bed effluent flows by gravitation to graded concrete channels round each bed, and is thence conveyed to thé land by means of 12-inch stoneware half-pipe carriers having removable outlets at intervals. It is intended to cultivate the land with Italian rye grass, and a small experimental bed of peppermint.

The system of sewers is a partially separate one, as it is intended to exclude all surface water from roads and only admit surface water from back roofs and yards where other means of disposal are not available.

It is intended to treat up to three times the dry-weather flow in the manner above described, any excess being conveyed by means of a 12-inch cast-iron storm-water main to a storm-water bed 86 feet × 40 feet by 3 feet deep, constructed on the westerly side of the outfall site, in such a position as to render the higher portion of the land available for irrigation of storm water. No sewage will be allowed to reach the collecting carrier or the effluent outfall drain until it has first passed over the land. The 12-inch effluent outfall drain has been constructed through private farming land to its termination in a public watercourse known as Boveney ditch, which communicates with the river Thames. The outfall site is situated in the parish of Hitcham, and is 12¾ acres in extent; about 10½ acres of this area will be available for irrigation of the effluent, the remaining portion being taken up with the works, superintendent's cottage, new road, etc. The soil of the irrigation area is friable loam overlying gravel and chalk, and is well suited for purposes of sewage purification.

PLATE No I.



WORKS.

To face p. 96.

The cost of the works will be defrayed out of a loan of £13,125, sanctioned by the Local Government Board, the details of the engineer's estimate being—

	£	s.	d.
Contract No. 1 outfall works	3050	0	0
„ „ 2 sewers	7550	0	0
„ „ 3 superintendent's house	500	0	0
Purchase of land, erection of fences, gates, etc., tenants' compensation for disturbances	1900	0	0
Easement, compensation, legal expenses, and contingencies	500	0	0
	£13,500	0	0

The Council applied to the Local Government Board for sanction to borrow the above sum of £13,500, which was granted, less a sum of £375 which represents the estimated cost of one bacteria bed not at present required to be constructed. A loan for £13,125 has been negotiated with The Prudential Assurance Company, at 3⅞ per cent., repayable in sixty equal half-yearly payments of principal and interest combined.

The works have been designed and carried out by the Author. The contracts for the whole of the works were satisfactorily carried out under circumstances of some difficulty owing to bad and waterlogged ground, narrow streets, etc. The works will be carried out and completed within the Author's estimate. In conclusion, the Author desires to thank the Council and members of the Association for honouring him with a visit, and trusts that the meeting to which, in conjunction with his colleague Mr. W. White Cooper, Surveyor of Slough, he is privileged to welcome the Association, may be a pleasurable and interesting one.

DISCUSSION.

Mr. R. Brown: Mr. Cooper has referred to the cost of gas-tar oil. I may say I have treated long lengths of road with oil-tar. Last year I did ten miles. This year I am doing the whole of the roads in Southall, and it gives very good results. The cost is infinitesimal. Mr. Cooper puts down the cost of his method of treatment at 1·88*d.* per yard super, and of the second dressing 0·94*d.* Mr. Cooper pays 2½*d.* per gallon for his material. I am in the happy position of being able to buy it at 1*d.* per gallon;

and the work cost less than $\frac{1}{4}d.$ per yard super. It is eminently successful in keeping down dust. We treated our roads three times last year at a cost of less than $\frac{3}{4}d.$ per yard. And by treating the roads in this way we saved at least £180 in upkeep. That is to say, the roads which required mending every year only require mending once in two years, as the oil-tar preserves the surface. I think the chief cause of the preservation of the road surface is due to the composition of the oil-tar, which contains 20 per cent. of pitch. The best way to treat roads to keep down the dust is to waterproof them with some material. I think that material can be found in pitch in a state of solution, as it is in oil-tar.

Mr. F. R. Phipps: The highways are stated to cost 10*d.* in the pound per year, and the drainage 1*s.* in the pound. I should like to ask whether the interest on, and repayment of loans, is included in that amount? [Mr. W. W. Cooper: Yes.] Then, is there any difficulty in compelling a separate system of drainage for every house?

Mr. S. G. Gamble: I see from the paper that Mr. Gladwell proposes to grow Italian rye and peppermint upon the land adjacent to the tanks. Some eighteen years ago I had charge of a sewage farm in Lincolnshire, where we were able to grow most satisfactorily crops of this kind, but they had to be abandoned, as the local sale of rye grass was so small, and the cost of carriage to the large towns so enormous, as to actually leave a deficit on the transaction. With regard to the peppermint, considerable trouble was experienced in setting up temporary appliances for its distillation, as it is necessary that the plant should be cut and distilled immediately it is ripe, in order to obtain the largest amount of oil. To do this in anything like an economical manner, it is necessary to grow an immense quantity of the plant, and to employ a trained staff for the purpose of extracting the oil; therefore, if it cannot be done in large quantities, or the product sent to a ready market, it will not prove a financial success.

The President: Mr. Cooper's paper is full of very interesting matter, particularly that part of it which relates to the immense saving he has effected by the use of Meldrum's furnace for utilising profitably the refuse which most people regard as a nuisance, and not capable of being utilised at a profit. I think Mr. Cooper is to be congratulated upon having adopted

a very profitable way of disposing of that refuse without nuisance, and at the same time effecting a considerable saving on his coal bill. Mr. Cooper has carried out his work with distinguished skill and ability, and with considerable advantage to the rate-payers.

Mr. JOHNSON HILL, Buckinghamshire County Council: I should like to hear some expression of opinion as to the method adopted by Mr. Gladwell in putting down the small piece of trial road, viz. beginning with the fine dressing, and finishing with the large material.

Mr. J. A. ANGELL: As regards Mr. Johnson Hill's query, I think it is one which we should all be very likely to ask; but it is quite possible that Mr. Gladwell is not in a much better position than ourselves to answer it. It is a remarkable inversion of the ordinary practice; whether it will be successful remains to be proved. I should like to ask Mr. Gladwell whether he thinks such a road would be as useful in a town where there is heavy vehicular and horse traffic, and especially horse traffic, as distinct from, or in addition to, motor traffic. In the first stages of such a road, the horses' feet would, I think, disturb the surface of the road very much, whereas motor traffic tends to bind it together. I am inclined to think that, with the heavy horse traffic of a country town as compared with a rural road, the surface would require much rolling by reason of the spongy or elastic nature of the tar macadam when first laid. One would like to know something more about oil of tar for surfacing roads. I have myself used a large quantity with very good results, better in some respects than with ordinary tar. With a tarred surface the watering required was but little less than in the case of an ordinary macadam road, but with oil of tar laid on a length of the same road, having precisely the same traffic, and under just the same conditions, the results during the summer months were very remarkable, no watering being required for many weeks during the hottest weather. But when I came to apply oil of tar to a gravel and flint road, disintegration of the surface of the road soon followed the discontinuance of watering. I do not think, therefore, that oil of tar, though useful for the harder stone, is suitable for flint or gravel roads. What I should like to know more of in respect to oil of tar, is its winter effect. My own experience of it in winter was not favourable, as I found the roads became very

sticky, and pulled up under traffic, the glutinous nature of the oil causing it to adhere to the wheels of vehicles; then again, objection was raised to the smell, and I had many complaints from shopkeepers, particularly from dairies and fishmongers. The fish when cooked, so I was informed, was flavoured with the tar-oil, so much so, that it was quite obvious whence it had been purchased. One is anxious, of course, not to apply oil of tar or any other material on a large scale merely to encounter minor but unanticipated difficulties such as that referred to. As regards the tar macadam which we have seen laid this afternoon, on the Bath road, what I should like to know is whether the material would give the same comparative favourable results as regards life in a town as in a rural district. In a rural district there is no watering, and, therefore, you lack in an ordinary macadam road a valuable binding agent, whereas a town road is regularly watered, and consequently disintegration is largely prevented. Apart from other considerations, therefore, tar macadam in a rural district should, as compared with ordinary macadam in the same district, show better results, as regards life, than should a tar macadam road in a town as compared with an ordinary macadam road in the same town. Then as to the question of repair: does any one know how to satisfactorily mend a tar macadam road at the different periods of its life, from its earliest stage of "squatting" or "patching" until its latest, when possibly, the tar has entirely perished, and the remaking of the road throughout its entire thickness is involved? The slipperiness of a tar macadam road is a feature of importance which should not be lost sight of in these days of motor-cars and cycles, whilst from a dust point of view, in a suburban district, with much horse traffic, and consequently horse-droppings, my experience is that unless either the road be kept superlatively clean by scavenging, the surface requires to be as frequently watered as any other road. A tar macadam road, indeed, though comparatively dustless in construction, may, unless its special and particular requirements as to scavenging are satisfied, still be a very dusty one.

Mr. G. W. Manning: I have had a good deal of experience in trying to make a dustless road. Three and a half years ago the Kingston and Windsor main road was laid with tarmac. A portion of the surface of the road was painted last year, and I am finishing it now. I found signs, where portions of the

road were sheltered under trees, of disintegration. It accumulated a lot of sticky mud that seemed to have the effect upon the surface of perishing the tar. I painted those places, and the whole of it stood last winter without any sign of disintegration. I have another piece of tarmac laid on the road to Kempton Park. That road is subjected to an exceedingly heavy traffic. On that road there was the same effect, and in sheltered positions the surface seemed to perish. That I painted last autumn, and at the present time the road shows no signs of disintegration. I painted it with tar, heated in small quantities in boilers on the road, and put it on as hot as I could. The tar was painted on as thin as possible, and it simply filled up the interstices, and practically for all intents and purposes the surface of that road is as good as what you saw on the Bath road to-day, the rough surface maintaining its good foothold and not becoming slippery. My Council tried practically all the dust palliatives, oil tar included, and at the next Council meeting the chairman told me if I didn't want to leave I had better discontinue the use of oil-tar, as he had received nineteen letters of complaint from shopkeepers and others. I have taken great interest in Mr. Gladwell's experiments. I watched the road which Mr. Gladwell was putting down to-day, and I noticed exactly the same effects as with the road I put down with tarmac. That road did not go down solid and steady, but went down slowly with the traffic. That also happened with the section of road which Mr. Gladwell laid last autumn. That road after it was laid was in exactly the same condition as the road you saw them making to-day. I certainly think if they have the tar renovated, the surface of these roads will last a long time. As to tarmac on town roads, the section I have laid in the town has been down for two years, and on the Kingston road three and a half years, during which time the granite surface has been twice repaired. The cost in the one case was 2*s.* 1*d.* and the other 2*s.* 4*d.* per yard super. Speaking from the rural point of view, the extended use of tarmac is entirely out of the question. If Mr. Gladwell's experiment proves satisfactory and successful in use, and that is the only thing to prove it by, and we can get a road which is to all intents and purposes waterproof, giving little or no dust under present conditions of traffic without watering, and having a longer life than an ordinary macadam road, at an

extra cost of *2d.* or *3d.* per yard super, then Mr. Gladwell has come nearer than any of us to solving the question of road maintenance for rural districts. You gentlemen who represent urban districts with bloated purses, look at this question in an altogether different way from what we can look at it in a rural district. We have to make the roads in winter, so we cannot make our roads when the work can be done with the greatest economy. We put down a road in winter and lose half the benefit of that work from the effects of frost and snow before it has settled. I am going to follow Mr. Gladwell by making an experiment on similar lines, and if I can get anything like his results, I am sure my Council will welcome the change for the better very gladly.

Mr. F. T. Clayton: I have for many years been experimenting upon this and other methods of road maintenance with a view to reducing the dust nuisance. I have control in the borough of Reigate of two of the main roads in the country, which are subject to excessive quick travelling motor traffic, being on the direct line between London, Brighton, and the South Coast. The dust question having become so acute, and likely to increase every year, I commenced some four years ago to think the question out seriously, and after a time I laid down three different methods of road repairs with the object of preventing dust. The first treatment was as follows: First scarified the existing road surface, and carefully formed the surface to the required cross-section, then I placed on the top the new granite surface of about 2-inch gauge material, and over this an adhesive matrix, specially prepared from my own idea of what the mixture should be, and then rolled the whole down by steam-roller. By this method the matrix is forced into the interstices of the stone, the road metal becomes set, and a road surface obtained, which is as near dustless as it is possible to get. The second method I tried was to scarify the existing road surface, then to place over that a layer of the adhesive matrix, and then to place the granite over same to form the new surface of road, and roll down by steam roller. After this I placed a covering of matrix over the granite, and well rolled again until consolidated. The third process I tried was to scarify the road surface, place the new granite over this, and roll down dry. After consolidation had been obtained, I placed a covering of the matrix over the surface, and rolled again until

well set. These treatments I found answered very well indeed, but the first method I found to prove most satisfactory, and this has been laid close upon three years on a main road, which is in excellent condition at the present time. In the winter season the road is quite hard and firm, and in the hot summer the surface becomes a little bit tacky, and just sufficient to absorb any dust that may be carried upon the surface. This method of repairing roads goes a long way towards removing the complaints from residents adjoining main roads, and approaches the solution of the dust problem as near as it is likely to be approached by any known process at the present time, and the cost is well within the point to which any Council, whether urban or rural, can go. The extra cost of my method of road repairs works out at about £58 per mile in excess of the old method of road repairing usually adopted, by using water and mud to bind the road surface, with its consequent mud and dust afterwards. From what we have seen to-day, which is a process similar to what I have used some two and a half years, I think the results will prove a distinct advance over the usual method adopted in road repairs.

Mr. R. J. Thomas: It is not the theoretical expert we hear so much about who will solve this question, but the road surveyor, who is bred and born to his work. Every attempt the road surveyor makes to solve the problem we welcome, knowing it will be based upon practical experience. In reply to Mr. Angell's question, relative to repairing tarmac; the top layer is cut out where holes are worn, and fresh material, heated on shovels, inserted, and either rammed or rolled; quite a simple process. You have seen a piece of tarmac which has been laid 3½ years, at a cost of 2*s.* per square yard, 1 ton covering 11 square yards. It is 3 inches thick, 600 yards long, and has only required 5 or 6 tons of material for patching holes in top layer, the bottom one being intact. This road has probably the heaviest fast motor traffic in the world, there having been counted 1200 cars passing in 12 consecutive hours, and 200 cars in 1 hour. Formerly a coat of granite lasted from 4 to 4½ years; now it lasts from 9 to 12 months. When the tarmac was put down on Salt Hill a coat of granite two stones thick was rolled at each end, and has entirely gone, whilst a third coat is now rapidly disappearing. The next repairs to this portion of tarmac will be a coating of 1½-inch material. We

have tried all the other specifics for preventing dust. But so long as the fabric is only held together by water binding, it is impossible to maintain its solidity, or keep down dust where motor traffic is at all heavy. It seems to me that unless we have large Government grants for at least the main trunk roads, their maintenance is going to run us to considerable expense. The cost of roads in England and Wales for the year ended March 1901, was £6,619,463; for the year ended March 1905, £7,413,508. This increase was divided thus: on rural main roads, £290,077, or 20½ per cent. increase; on urban main roads, £68,072, or 9½ per cent.; on rural district highways, £267,850, or 14½ per cent.; on urban district highways, £129,200, or 9½ per cent.; county boroughs (all roads), £38,846, or 3 per cent. The increase in annual cost in four years was thus: £794,045, or 12 per cent. over all. Since March 1905 (the last completed year for which accounts are obtainable) the growth in expenditure has undoubtedly continued. The moral of these figures is obvious—that the greatest injury is done to country roads where the fast traffic has a free run and watering is impossible. Until we get increased sums from the Exchequer to meet the increased outlay caused by this traffic, we are suffering very seriously. This motor traffic is not local, but covers the country from Cornwall to John O'Groat's, and should be provided for by national rather than local funds. The whole of the motor-car registration fees in Buckinghamshire come to £200 or £300 per annum, whereas we are spending from £5000 to £6000 per annum more on our roads. It is very obvious that something must be done to provide the funds for making our roads to stand the traffic.

Mr. A. H. Campbell: I should not have taken part in this discussion but for the remarks of Mr. Manning. He said in effect that tarmac was so expensive as to make its use for rural roads utterly prohibitive. I rise to utter my protest against that observation; I hope it will not go forth as an expression of the views of Members of this Association. After we have been over the county roads to-day, which have been made at a cost of about 2*s.* per yard super, and seen their condition after three or four years' wear, no one can say this is a costly material for highways. It represents a cost of 6*d.* to 8*d.* per annum for maintenance, which is remarkably economical for roads carrying heavy traffic. I am not going to compare tarmac with what

Mr. Gladwell has shown us to-day; experiments for which we ought to be thankful. I think any one who is attempting to elucidate the problem of highway maintenance deserves our gratitude, whether success or failure attend their effort; for we learn as much from failure as from success. I am not in entire agreement with the method adopted by Mr. Gladwell. I speak subject to correction, but from observation to-day I do not like the interposition of the small material as a matrix between the hard basis of the road and the superimposed granite. If you have got a depression on the old road surface caused by wear and tear, how are you going to assure that the material is not going to assume the same wavy condition as the road. I have been trying as a matrix dustabato; I have half a mile of road under medium traffic laid with various materials; 200 yards is laid with Dustabato. First of all I scarify the road with a mechanical scarifier. I then put on 2½ inches of Guernsey granite; thoroughly well roll that, and then a man pours on this dustabato composition as a flux, until it goes all over the surface and permeates every interstice in the road material. Then I put on a covering of about one-eighth of an inch thick of Guernsey granite spar. I then roll it with the steam-roller, and in about three hours it is about as hard as a rock, even in the presence of a strong sun, such as we have had this past few days. I cannot yet speak of its wear; but it promises to be fairly durable, and what commends it to us is the rapidity with which it sets, and the road can be used for traffic. The cost is 6*d.* per yard above the ordinary macadam. This is not a heavy charge, but, of course, it is different from Mr. Gladwell's 2½*d.* to 3*d.* per yard, though I have no doubt if we had him under cross-examination we might get him to admit 4*d.* per yard. Tarmac is 8*d.* per yard. There is not a great deal of difference in the cost when you consider the promise of longer life of these roads as compared with other cheaper expedients and materials. I have experimented with the matrix between two layers of Kentish flint, and that road is giving good results. I have also tried another length of road about a quarter of a mile with ordinary gravel ballast carefully sifted. We have had a superfluity of unemployed, and I have been converting a marshy waste into a beautiful lake. One of the results has been an accumulation of a lot of ballast, which I am trying to use on the roads, with nothing but tar spray

over it, then top dressed with granite spar. That promises to be good. But as to the durability of the different sections of road I cannot speak to-day. Altogether I am bound to say I have seen nothing to excel the long lengths of road shown to us to-day by Mr. Thomas made of tarmac. It is the dust we want to prevent and suppress, and one cannot but be gratified by the entire absence of dust on these roads. I should like some time to show the Members of the Association the length of road we have laid in my district.

Mr. MANNING: I am one of those who think that the first cost of laying tarmac is out of the question on rural roads; that is, the relative difference in the price between a coating of granite and the putting down of tarmac. The cost of a light coat of tarmac comes out at about 2*s.* per yard; the cost of ordinary granite from 1*s.* 2*d.* to 1*s.* 4*d.* Where the difficulty comes in in country districts is that, if you are putting down tarmac, you have to go from haunch to haunch and practically reconstruct the whole of the road, while with ordinary macadam at the outside you only run a width of about 12 feet in the centre of the road. The Kingston road cost us nearly £900 per mile when changed from a flint road to a macadam, and converting it into a tarmac road cost us close on £1200 a mile. That is where we cannot stand the first cost. The ordinary cost of the maintenance of a mile of road in my district is just over £60 per mile. In Mr. Gladwell's case it is a road which carries a considerable amount of traffic, and it is necessary to go from haunch to haunch on account of its width, but I see a great future for his system, for without any expensive reconstruction works a road can be crowned in the ordinary way. The other great advantage is that all this work can be done best in summer weather, and without the application of water.

Mr. N. H. DAWSON: I wish to ask Mr. Gladwell what gauge of granite he considers the most suitable for repairing these roads, and I wish to ask Mr. Cooper if he does not find the paving flags made from clinker slippery in frosty weather? They have a smooth face, and I am afraid they would prove very slippery, especially on a steep gradient, and anywhere but on the level.

Mr. M. A. PIERCY: I should like to ask Mr. Cooper whether he uses the small slabs for kerbing, and if so whether he finds

them at all slippery, and whether they are durable or not? My experience of concrete kerbing is that they are not so. I should like to know if they are used for that purpose or simply for channels.

The President: We are very much obliged to Mr. Cooper and Mr. Gladwell for the papers they have prepared, and the works they have shown us, and likewise for their kindly entertainment at tea. And we must not forget Mr. Thomas, the energetic secretary of the Home Counties District. To these three gentlemen we accord our warmest and most sincere thanks.

A hearty vote of thanks was accorded by acclamation.

Mr. Cooper, in reply, said: I should like to make reply to one remark made by Mr. Thomas. I think he said it was the rural and not the urban authorities who suffered most heavily from the great expense of maintaining the roads. If I am correct I certainly demur to that statement. That is not the experience in Slough. We know to our cost the very heavy expense we are put to in maintaining our roads, and I often hear from my Council that if the Bucks County Council would be more liberal we should get on very well. Last year my Council permitted me to make an experiment with oil-tar, owing to the large quantity of dust on the Bath main road. I treated a half-mile length with very gratifying results, so much so that the Council have determined to extend the experiment this season, treating a further length of five or six miles of road. I found it not only laid the dust to a very great extent indeed; but also reduced the ordinary cost of watering. The liquid was brought to boiling point, and put down very hot; a method which I think is unusual with this class of material. The road lasted twelve days without any watering, and even then there was only a very slight rising of dust with a fast moving car, and no dust whatever was perceptible from the ordinary traffic. At a later stage a second coat was put on, and for the remainder of the summer very slight watering was required. Taking the cost of the ordinary watering, which is £65 a mile, I find by using oil-tar we could reduce the cost of watering by 20 per cent. It is not intended to use this oil-tar on roads where there are shops. I should hesitate in so doing, but on the outskirts of the town I shall use it. During the winter months this particular length of road stood perfectly well. It retained

its waterproof surface; there was little scavenging required, and I did not find the stickiness one of the speakers referred to. As to the flag making, I do not find the flags wear slippery. We are favoured that way; our gradients are very low. The blocks are used only for channels and crossings. I have made some for kerbs, but my clinker is not of that good character I should recommend for kerbs, but for channels and crossings and pavements I find it answers very well.

Mr. A. GLADWELL, in reply, said: I must add my meed of thanks to that expressed by Mr. Cooper for the honour the Association has done both of us in arranging a meeting in our locality. It has been a source of great pleasure to me personally to receive the Association, and I feel grateful to the President for having arranged that the meeting should take place. The expense of the cleansing of cesspools is specially charged to each parish under section 230 of the Public Health Act, 1875. As to the sale of rye-grass, and what arrangements we have for the distillation of peppermint, I am afraid the question was asked under a misapprehension, because when the members went down to the sewage works, which are only now on the point of completion, they saw that the rye-grass had attained a height of two inches, and the peppermint had not yet been sown. With respect to what Mr. Cooper said as to spending £65 per mile for watering, I may say that is £23 per mile more than I spend on my roads for maintenance. With respect to the question Mr. Angell asked as to the effect of heavy town traffic on the surface of the roads which I have shown you to-day. I don't pretend to know more about it than the experience of nine months has taught me. This thing is in its infancy, as tarmac was in its infancy five years ago. Tarmac has had about five years of life—(a Member: Twenty-five or thirty years.)—I mean the particular tarmac we have seen to-day. The first process I attempted was about nine months ago, and I hope some of the urban surveyors will put it under the severest tests, in the interest of the problem of road maintenance generally. It is not necessary to lay a very great length of it; and the experiment cannot be very costly, as you have the granite if it should prove a failure. I must say I am struck with the fact that the whole of the discussion to-day has resolved itself practically into a consideration of the road question. I had great hopes after showing you the little sewage

scheme which I have designed and carried out that something might be said upon it. I can only assume that it is so perfect that no one can find anything to criticise. I feel grateful to Mr. Campbell for the words of commendation he has used to one who is attempting to elucidate the dust problem. What I have shown you to-day I do not presume to say is the final word to be said on this question of road making. I am still a student, as others will have to be for a long time to come. With respect to Mr. Campbell's remark as to depressions in the road, if depressions in the road owing to previous traffic interfered with the correct contour you would have to regulate that in any system. Therefore you cannot say that costs more in my system than in any other. If the depressions are unimportant you can regulate them by putting on a little thicker coating of stone, with the result that you have a little more material on one part of the road than another. Then as to the 2½*d*. per yard additional cost for the bituminous sealing flux for the road surface. I quite appreciate Mr. Campbell's remark, and it is probable under skilful cross-examination, I might alter my figure to 4*d*. per yard. But I am not going to alter it to-day, I intend to make further experiments under that head. There is a question by Mr. Dawson as to the gauge of the granite used. That is also a question of experience. I have 2-inch hand broken granite from one firm, which is a good deal larger than 2½-inch from another. If the Standardisation Committee could take the standards of granite into consideration, I am sure they would earn our gratitude. The best size of granite to use is entirely a question of experience, and I am not prepared to offer any advice. All I can say is that the granite should be about two inches in gauge. I feel greatly honoured in being permitted to take any part whatever in the solving of this great question, and the encouragement I have received will only act as a stimulus to me in future, and I trust that others will give attention to this great question, and let it not be said that we road surveyors cannot solve it for ourselves.

The President and Members first proceeded in motor vehicles to the Slough pumping-station, where an opportunity was offered of seeing the Meldrum furnaces disposing of the house refuse, the clinker residual being used for the manufacture of flags for the paving of footpaths. The electricity generating-station at Chalvey,

and the Salt playing fields, were visited. The afternoon was devoted to the inspection of roads which had been made of tarmac, and also, according to the specification described by Mr. Gladwell in this Paper.

The Members had luncheon together at the Crown Hotel, Slough, and at the conclusion of the visits were entertained by Messrs. Cooper and Gladwell to tea at the Dumbbell Hotel.

IRISH DISTRICT MEETING.

May 17 and 18, 1907.

Held in the City Hall, Donegal Place, Belfast.

J. Patten Barber, M.Inst.C.E., President, *in the chair.*

The Earl of Shaftesbury, the Lord Mayor of Belfast, received the Members and offered them a hearty welcome to Belfast.

The President, on behalf of the Association, thanked his Lordship for the very kind welcome he had given them.

Mr. R. H. Dorman was unanimously re-elected Honorary Secretary for the Irish district.

SEWAGE PUMPING STATIONS AND MACHINERY.

By HENRY A. CUTLER, M.Inst.C.E.,
City Engineer, Belfast.

The installation of machinery for pumping sewage, although necessary only in low-lying districts from which sewage cannot be discharged by gravitation, presents problems which most municipal engineers at some time during their career have to solve.

Wherever possible, discharge by gravitation is to be preferred, and pumping to be avoided, for a study of the problem to be dealt with in a pumping scheme reveals conditions, which are not only difficult and costly to satisfy, but require constant vigilance to prevent flooding, even when the greatest care has been exercised in designing and installing the plant.

In preparing a scheme for the drainage of a district it is almost invariably necessary to take into consideration sewers which are already in existence, and frequently to recommend

a scheme which, although the best possible under the circumstances, falls short of what might have been otherwise accomplished.

In the drainage of a district where pumping has to be resorted to, it is a matter of considerable importance, where the whole area is not low-lying, to make the area from which sewage is to be pumped as small as possible by a proper selection of site for the outfall works, and to collect the sewage from the higher zones by intercepting sewers which will discharge by gravitation. In locating the position of a pumping station one might, without giving much thought to the matter, select a site at the outfall works, which would usually be outside the probable building area, or at any rate far removed from the centre, but in many cases such a position would by no means be the most suitable or economical. Generally speaking, it may be taken that the site for a pumping station in a practically flat district is a central position on the bank of a river or stream, towards which the sewers would converge. With such a site the sewers necessary would be comparatively small, short, shallow, and inexpensive, and the height to which the sewage would require to be lifted reduced to a minimum, thus reducing the horse-power and first cost of machinery, as well as the annual expenditure.

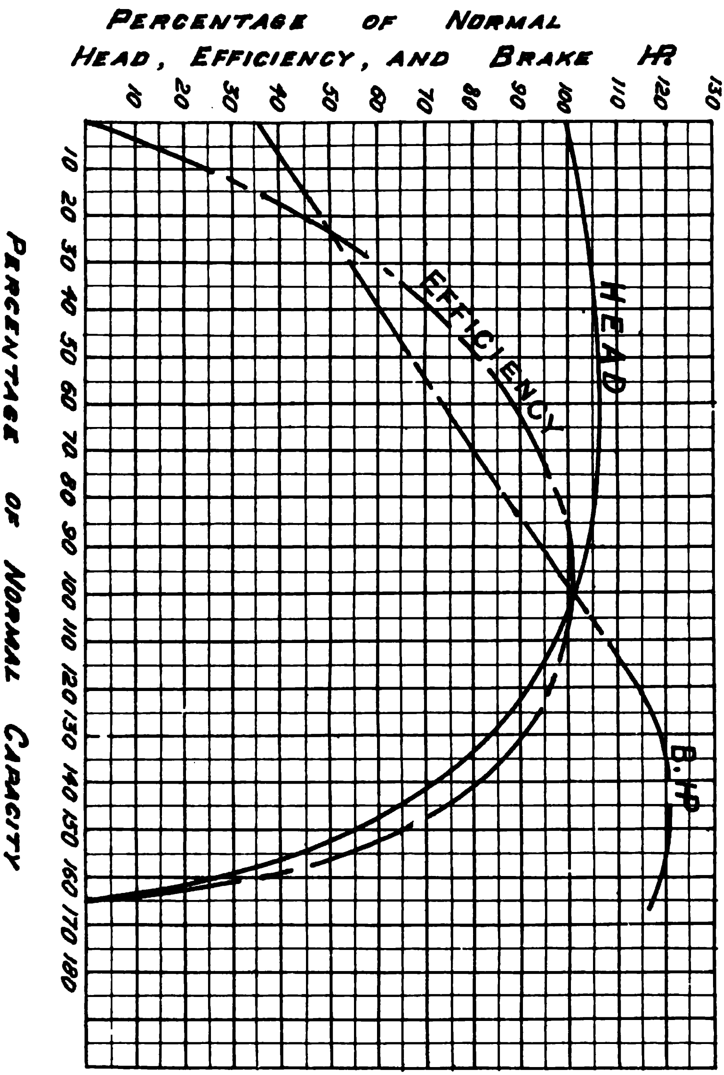
Against the selection of a central site it might be urged that the sewage would have eventually to be pumped to the outfall works through an expensive main under pressure, which would counterbalance the saving in the cost of sewers, and that the power required to overcome the friction in the pipe would at least equal the saving effected by the reduction of the lift; but it must not be forgotten (1) that the maximum quantity of sewage to be treated to comply with the regulations of the Local Government Board is only six times the dry-weather flow, whereas the sewage flow in times of heavy rainfall is vastly in excess of that amount, and (2) that such excess can be pumped direct into the river or stream by special storm-water pumps. Of course, if a free outfall into rivers or streams could be provided for storm-water without pumping, either by storm overflows or separate surface-water sewers, or if the district to be drained had a declivity all in one direction, a centrally situated pumping station might not be the most suitable. Another important matter for consideration in determining the site for a pumping station is the facility for obtaining fuel, or

PLATE No. I.

To face p. 112.

PLATE No. VI.

CHARACTERISTIC CURVES
OF WORTHINGTON MEDIUM LIFT CENTRIFUGAL PUMPS FOR CONSTANT SPEED



To face p. 112.

PHOTO LITHO. R.J. EVERETT & SONS 13 BARTLETTS BUILDINGS, HOLBORN CIRCUS

electric, water, or other power for driving the machinery. When a site for a sewage pumping station has been decided upon, the estimation of the maximum quantities of sewage and storm water to be dealt with, and the power to be used in driving the machinery, require a great deal of practical consideration, especially in view of the enormous difference between the minimum dry-weather flow, and the flow during storms.

Although in designing a complete sewerage scheme the volume of sewage to be dealt with will have been arrived at in designing the sewers, it is necessary to give data and to discuss the question of the relation between rainfall and sewage flow in dealing with the subject of this paper.

For the estimation of the volume of rainfall to be dealt with in any period of time, the records from the ordinary rain-gauge are of no value, as the rain which has fallen is only measured every twenty-four hours; but there are several forms of recording rain-gauge in the market which record the rainfall on a time-chart worked by a clockwork drum, so that the exact amount which has fallen during any period of time can be obtained.

The vertical ordinates to the curve on Diagram 1 measure the maximum rate of rainfall per hour for any period up to two hours computed on the records of the past three years, obtained at the Belfast Outfall Works. The ordinates of the curves are arrived at by an inspection of all the rainfall diagrams, and selecting the maximum rainfall for each period of 5, 10, 15 minutes, and so on up to two hours, and working out from them the equivalent rate per hour; that is to say, if half-inch fell in 30 minutes, the rate per hour for 30 minutes would be one inch. In estimating the rate of rainfall to be dealt with at a pumping station, it is necessary to know the time the water takes to travel in the sewers from the furthest considerable area of the district drained. The rain, after it has fallen, has first to flow over yard, road, or roof surfaces, and through drains before it arrives at the sewer, which it reaches in an average period of about five minutes; it has then to pass along the sewers at velocities due to the gradients, from which the remaining portion of the time required to reach the pumping station can easily be calculated. When the total period of flow to the pumping station has been found, as above indicated, the maximum rate of rainfall per hour to be dealt with by the

pumping machinery (assuming there are no storm overflows) can be ascertained from a diagram similar to Diagram 1, by measuring the ordinate of the curve corresponding to the period of flow. As an example of the use of the diagram, let it be assumed that the period of flow was found to be one hour, then the ordinate of the curve corresponding to such period would measure 0·66, which represents the rate of rainfall (in inches per hour) corresponding to such period of flow.

The percentage of the rainfall which may be expected to flow off from the area drained depends upon the nature and declivity of the surface, and must be estimated with due regard thereto. If the whole surface is practically impervious, as in densely populated areas, the whole quantity in time of continuous rainfall may reach the sewers, but in residential districts or sparsely populated areas a percentage only of the total rainfall will have to be dealt with by the pumps, which will vary according to the area built upon, the area of road surface, the area of land draining into the system, and the general slope of the area.

A district to be drained will almost always contain various classes of property, from which varying percentages of total rainfall will reach the sewers, and this must be considered in conjunction with the rate of rainfall in determining the ratio of minimum to maximum flow in the sewers.

On the supposition that the sewers are practically water-tight, the volume of sewage, as distinct from rainfall, to be dealt with depends upon the water supply, and may generally be taken at 30 gallons per head per day. As an example of the variations in flow, for which provision has to be made in sewers, consider the case of a locality of working-class dwellings, with a density of population of 250 per acre, and where the extent to be drained and the inclinations of the sewers are such that the flow takes 30 minutes to reach the pumping station. Assuming a dry-weather flow of 30 gallons per head, the average *sewage* flow per acre will be 50 cubic feet per hour, and with the rainfall conditions which obtain in Belfast, on which Diagram 1 is based, the rainfall intensity (for 30 minutes' flow) will be 0·66 inch per hour, or 2420 cubic feet per hour per acre. This gives a ratio of storm-water to average sewage flow of about 50 to 1, or (assuming that the minimum sewage flow is half the average) a ratio of maximum

rainfall to minimum sewage flow of about 100 to 1. Enormous as such a variation in flow appears, it is not exceptional if subsoil water is entirely excluded; and, where storm overflows are impracticable, such a variation must be considered and provided for in designing the pumping plant.

The variations in flow may be dealt with at a pumping station by impounding, by dividing up the plant into several units, or by varying the discharge of the pumps, but usually all three methods are resorted to. The plant required to deal with the sewage to be treated at the outfall works (*i.e.* six times the dry-weather flow) may be considered separately from the storm-water plant, and as it will be more constantly at work than the latter, more regard should be paid to its efficiency.

The plant for dealing with storm-water will not be in frequent operation, and will very seldom be worked to its full capacity, and as no rule can be laid down for the variations of rainfall intensity, the number and duration of the periods during which the plant will be at work are unknown quantities. The total annual quantity of storm-water that will require to be pumped can be approximated from the average annual rainfall, but what proportion of that quantity will fall with such intensity as to cause a flow in the sewers exceeding six times the normal sewage flow, and thus require the storm pumps to be operated, is also an unknown quantity, for which, at best, an average measurement only can be obtained, even with carefully kept records. To sum up the position with regard to storm-water, we can only approximate the maximum rate of flow and the average annual quantity to be dealt with. To ascertain the total annual quantity of rainfail to be pumped compared with the total quantity of sewage, our approximation can be made in the following manner:—Assuming that the district, with regard to which we are making investigations, consists of 100 acres of impervious area, containing 250 persons per acre, 50 acres with 75 per cent. of impervious area, containing 100 persons per acre, and 50 acres with 25 per cent. of impervious area, containing a population of 20 persons per acre, and that the average annual dry-weather flow is 30 gallons per head, the total annual flow will be

$$\frac{(100 \times 250 + 50 \times 100 + 50 \times 20)(30 \times 365)}{6{\cdot}25} = \text{say, 54 million}$$

cubic feet.

For the same district, assuming an average annual rainfall of 35 inches, and that the whole of the rainfall on the impervious portion of the district flows to the pumps, and that the pervious or partially pervious portions contribute nothing—which is not strictly accurate, but near enough for the present purpose—the average annual quantity of rain water to be dealt with will be $\left(100 + \frac{50 \times 75}{100} + \frac{50 \times 25}{100}\right)(4840 \times 9 \times 2 \cdot 92) =$ say, 20 million cubic feet. From these calculations the total annual quantity of rainfall to be dealt with compared with the total annual sewage flow in the district described is only 37 per cent. Assuming what might be considered a worst possible case, that is to say, a wholly impervious area, with a population of about 120 persons per acre, and an average annual rainfall of 42 inches, the total annual rainfall compared with sewage flow would only be 72 per cent. On an average it may be assumed that the total quantity of rainfall to be dealt with is equal to 50 per cent. of the sewage flow.

To prevent the possibility of a total breakdown, the pumping plant intended to deal with the sewage to be pumped to the outfall works, should be divided into at least two separate units, and in moderately large stations, where the sewage cannot be impounded, a larger number of units would be desirable to economically deal with the possible fluctuations of flow, viz. from half the average to six times the average, or ranging from 1 to 12, because, as a rule, the nearer to full load the plant is worked the greater the economy. With the plant divided into two units, one unit might have a capacity of twice the average flow and work from quarter to full load, and the other unit a capacity of four times the average flow and work from half to full load, for when the quantity to be pumped exceeded twice the flow, but was less than four times the flow, the smaller pump could be shut down and the larger operated. A more economical arrangement, theoretically, would be three units, one having a capacity equal to the average dry-weather flow, so that it would only require to be worked between half and full load, and the other two each a capacity equal to two and a half times the daily flow, the efficiency of the two larger sets being of less importance than the smaller one, as they would be less frequently in use. If the sewage can be impounded in a tank or reservoir to balance the fluctuations, then

with a three-unit plant, as above described, the smallest unit could be worked continuously at full load. The plant to deal with the storm-water in excess of that to be pumped to the outfall works, as has been shown, may have to deal with a rate of flow of from 6 to 50 times the average daily dry-weather flow, or even more. The storm-water pumps should consist of at least two units, each capable of dealing with at least half the excess of the maximum storm flow over 6 times the average daily sewage flow; their range of work could then be kept between about quarter and full load.

As the capacity of the plant has to be sufficient to deal with the maximum intensity of rainfall, which very seldom occurs, most of the units will usually be standing idle, so that there should be no difficulty in keeping the plant in order, and no necessity for duplicating the plant.

So far the number of units required has only been considered generally, but the power to be used and the kind of pump to be installed deserve and require careful consideration in this connection. Limits of from quarter to full-rated speed are practical limits within which steam-engines or water-turbines can be worked without undue loss of economy, but gas and oil-engines can only be varied at the most between half and full-rated speed. Ordinary electric motors are constant in speed, but reliable variable speed electric motors with a range of 4 or even 6 to 1 can be obtained; they are, however, somewhat larger and more expensive than the ordinary type. The pumps commonly in use are either the reciprocating or centrifugal type, but while reciprocating pumps can be worked within fairly wide limits of speed and discharge, without much loss in efficiency, the range of speed through which a centrifugal pump can be worked is very limited, and its discharge can only be varied by varying the head.

Reciprocating pumps of a large capacity, especially when working under a considerable head, and direct coupled, are more economical than centrifugal pumps, but for simplicity, low capital cost, and cost of maintenance, they do not compare favourably with centrifugal pumps. For small units, belt-driven or driven through gearing, centrifugal pumps can be obtained for reasonable heads (say 100 feet, or even more), which will give a greater efficiency than reciprocating pumps.

From the foregoing remarks it will be seen that for pumping

storm-water, where economy of working is not of first importance, the centrifugal pump is the most suitable, in all cases where a sufficient number of units can be installed so as to work within the economical range of discharge, or where the difficulties of varying discharge can be overcome by impounding.

For the portion of the plant more constantly in use where efficiency is of primary importance, the question of size, gearing, and impounding, must all be considered in coming to a satisfactory conclusion, but it is usually desirable to have a reciprocating pump for one of the units dealing with the sewage to be pumped to the outfall works, so as to get the advantage of its greater speed range, provided the driving machinery is capable of giving the same variation of speed.

The centrifugal pump has been much improved in recent years, both as regards its efficiency and the head under which it can be worked, and there are pumps in the market to-day with efficiencies as high as 70 to 73 per cent., varying according to size. Practically the delivery of a centrifugal pump cannot be varied by change of speed, but it can be indefinitely varied from no delivery to about 60 per cent. above its normal capacity by varying the head, but not without loss of efficiency.

In considering the possible variations of discharge for centrifugal pumps it must not be forgotten that the static head under which sewage is to be pumped is usually constant, and that the artificial head due to friction (which is related to the quantity of sewage being pumped) is the only part of the total head which is variable. If several pumps discharge into one delivery main they will be working under maximum head (which they should be designed for) when all are discharging together; but should some of the pumps be out of commission, the head required to overcome friction would be less, and the total working head would be reduced. If the delivery-main is of considerable length, the reduction of flow through it when some of the pumps are not working might so reduce the head as to cause an appreciable increase in output and decrease in efficiency of the pumps remaining in work. An increase in output will, under some conditions of head and discharge, result in an increase of work done, which, with the loss in efficiency, will increase the horse-power required. Although, generally, it is not possible to increase the discharge of a centrifugal pump above its normal capacity by reducing the working head, it is

always possible to vary the output by increasing the head, and thus diminishing the discharge. The increased head can be obtained by partially closing the pump delivery-valve, but the horse-power required to drive the pumps and the pump efficiency would thereby be reduced. The efficiency of centrifugal pumps by different makers varies considerably, but pumps giving an efficiency of 72 per cent. at full load (which is lower than some makers will guarantee) will give efficiencies of 36 per cent., 58 per cent., and 68 per cent. at quarter, half, and three-quarter load respectively. The motive power for working pumps may be either steam, gas, oil, electric or water power, but the conditions obtaining in each particular case should govern the selection. Steam-engines are suitable for driving either reciprocating or centrifugal pumps, either by direct coupling, by belts, or by gearing, as they can generally be made to run at the speed suitable for each case. But gas- or oil-engines and electric motors are unsuitable for driving reciprocating pumps, except by belts or gearing, on account of their comparatively high speed, and gearing, where possible, should be avoided, owing to the loss of efficiency which it entails.

The suitability of gas- or oil-engines for driving the *larger* centrifugal pumps is undoubted, as the engines and pumps may be designed to run at the same speed and so may be direct coupled, but as regards the smaller centrifugal pumps, their speed would usually be so much greater than that of the oil- or gas-engine as to require the use of belting or gearing.

Electric motors are well adapted for the driving of centrifugal pumping-plant, as their efficiency is well maintained over wide variations of load and speed, in which respects they are superior to other forms of motive power. Where electric power can be obtained at a reasonable rate, it is a most suitable and economical power to use where the load is so variable, as at a sewage pumping station, but it is conceivable that a demand which is normally only a few horse-power but which may at any time for short periods jump to hundreds, would not be so attractive to an electric supply company as to induce them to supply at a very low rate. Among other advantages, an electric pumping station occupies comparatively small space, and the plant requires little attendance, as the units to deal with any flow above the normal can be started and stopped by suitable float-operated rheostats.

COUNTY ROAD MAINTENANCE IN ULSTER.

By J. W. LEEBODY, Co. Surveyor Co. Tyrone (S).

There is a well-known saying to the effect that "one half of the world does not know how the other half lives," and it is to be feared the saying is only too true of the particular branch of the profession to which most of those present have the honour to belong.

It occurred to the Author that it might not be altogether uninstructive and uninteresting to a gathering, which largely consists of those who are non-Irish, if some idea were given of the conditions under which Irish County Surveyors carry on their work, with a more or less detailed account of the system of road maintenance as it exists in the Province of Ulster.

Prior to the year 1836, the maintenance of Irish roads was divided among four distinct authorities, viz.—

1. Grand Juries of Counties.
2. Turnpike Trusts.
3. The Board of Public Works.
4. Municipal Street Boards.

The institution of the Grand Jury dates back to the time of the Norman invasion of Ireland about 1166, but there is no enactment among the Irish Statutes dealing with the Grand Jury until the year 1634. From that time on the Grand Jury was the recognised body for the regulation of fiscal affairs. In their early days the Grand Juries appear to have been very select bodies, who deliberated with closed doors and raised and spent large sums of money without being subjected to any adequate control either in the matter of expenditure or of work executed. As a natural result considerable corruption appears to have gradually developed. In the year 1836 an Act was passed to consolidate and amend the then existing Grand Jury statutes.

In the year 1853 the roads which had been in the control of

the Board of Public Works were handed over to the respective Grand Juries, and in the year 1857 the last Turnpike Toll was abolished.

From that date until the year 1889 the maintenance of Irish roads was in the hands of two classes of authorities, viz.—

(1) Grand Juries of Counties.

(2) Urban Councils.

The Local Government (Ireland) Act, 1898, which came into operation on April 1st, 1899, transferred all the fiscal work of the Grand Juries to County and District Councils.

In Volume XX. of the "Proceedings of the Association of Municipal and County Engineers" an account of the Grand Jury system by the late Mr. R. B. Sanders will be found, so that, except for an occasional comparison, it will not be further referred to.

A short account of the constitution and functions of the new bodies may be of interest. Each County is divided into Rural Districts, which for road and other purposes are quite distinct. The Rural District Councils consist of two members elected to represent each District Electoral Division, together with three co-opted members, if the elected members so decide. The County Council consists of one member elected by each County Electoral Division (which consists of a number of District Electoral Divisions) together with the Chairman of each Rural District and two co-opted members, if it is so decided. Both Rural and County Councils hold office for a period of three years and are corporate bodies having a perpetual succession, and can therefore sue and be sued in their own name. The Grand Juries and Presentment Sessions were not incorporated, and no action lay against either of them. The Chairman and Vice-Chairman of both District and County Councils are elected annually.

A woman may have a vote for the election of both District and County Councils, but she cannot hold either office herself. In the matter of roads a County Council has no power of itself to initiate any expenditure whatever, except in the case of repairs to "Sudden Damages," where, on the certificate of the County Surveyor that the repair cannot be delayed without prejudice to the public, repairs to the value of £50 may be carried out. The District Council is the starting-point for all road expenditure, and its functions may best be illustrated by

following an application involving the expenditure of money through its various stages. District Council meetings are, as a rule, held quarterly, but if a County Council by a two-thirds majority so resolve, the Local Government may sanction half-yearly meetings. Applications for work may be made by any Councillor or by the County Surveyor.

Generally speaking Councillors' applications are for new work, the County Surveyors' applications being confined to the maintenance of existing works. Each application must state clearly what it is for, how much it is likely to cost, and the source from which it is proposed that the money to defray the cost shall come. Councillors' applications must be lodged with the Clerk of the District Council on or before a date fixed by the County Council at least twenty days before the District Council meeting, the date of which is also fixed by the County Council. County Surveyors' applications can be lodged at any time up to the hour of meeting. A list of all applications received up to the appointed day is printed and published. At the meetings the various applications are considered *seriatim*, and if approved—with or without modifications—they become "proposals." The District Council has, however, no power to increase in the "proposal" the amount of money set forth in the "application," and in the case of new work, if the amount required exceeds £50 the proposal can only be passed "provisionally" in the first instance, and must come up for consideration at the succeeding quarterly meeting. After the meeting a list of "Proposals" is published, and tenders are invited on behalf of the County Council, except in cases which involve the acquisition of land, in which case the land must be acquired before any tenders are invited. Tenders must give the full name and postal address of the person tendering, and must state a bulk sum for the work—together with the name of two persons willing to guarantee the performance of the work. Under the Grand Jury, contracts were taken at so much per perch, and as it was customary for the contractors to make applications themselves for the renewal of contracts when the old ones expired, it was extraordinary how the distance between two fixed points grew from year to year; the further they got away from each other *on paper* the better for the contractor.

Tenders are opened at the adjourned quarterly meeting, and

bonds which have been prepared by the clerk of the District Council are then entered into. The District Council is not bound to accept the lowest or any tender, but where they do not accept the lowest tender a special entry has to be made in the minutes for the information of the Local Government Board. Moreover, the acceptance of any tender is subject to the approval of the County Council. Lists of the various "proposals" (known as *Form* 20) together with the accepted tenders and bonds are now sent to the County Council for consideration, but its functions as already indicated are limited to the approval or rejection of the proposals, and it cannot consider a "provisional proposal" at all.

It may, however, suggest modifications to the District Council, and, in the case of new work, may hold over its final decision for a period of three months to enable further particulars to be furnished. Following on the lines of the Grand Jury system, it was originally intended that all road maintenance should be executed by contract only, although in the case of masonry work direct labour might be employed, but that has been modified, and, since 1901, provided a road has been included in a "Direct Labour" schedule, which has received the sanction of the Local Government Board, the County Council can arrange to work it either by contract or by direct labour. The County Councils have power to revise a direct labour schedule at intervals of three years.

Where no tender has been received for a proposal sent forward by the District Council, the County Council may put the work into the hands of the county surveyor for a period not exceeding twelve months, the sum to be expended not to exceed that mentioned in the proposal—whether it is scheduled for "Direct Labour" or not.

Payments may be made quarterly or half-yearly at the discretion of the County Council, with the consent of the Local Government Board, but no payment can under any circumstances be made except upon the certificate of the county surveyor, lists of such certificates being submitted to the District Council at the stated meetings. Advances may be made to contractors on the certificate of the county surveyor at any time up to 85 per cent. of the value of the work completed.

The Author now desires to direct your attention to the

practical working of the system in Ulster, pointing out some of the difficulties in administration which are met with. The province of Ulster consists of nine counties, which, for road maintenance purposes were, at the passing of the Act of 1898, divided into 2 County Boroughs, 11 County Districts, and 25 Urban Districts. The nine counties are divided into 181 County Electoral Divisions, each returning one member to the County Councils, and 910 District Electoral Divisions, each returning two members to one or other of the Councils of the 59 rural districts into which the District Electoral Divisions are grouped. The County Councils are all of a workable size, but the great majority of the District Councils are much too large. It is said that there is "wisdom in a multitude of counsellors," but, at any rate, there is undoubtedly "much speaking."

By the Act the amount of money which any particular District Council can devote to road maintenance in any year has been fixed at a figure, being 25 per cent. in excess of the sum which the Local Government Board certify to have been the average yearly expenditure during the three years before the passing of the Act of 1898. The Author has not yet met any person who could explain how these certified figures were arrived at, but having got them, they are what we have to work upon. The total annual sum available for road maintenance and improvement is £343,218, and, approximately, the amount expended is £337,857. One cannot help feeling that somewhat better results than are actually found might be got for the money. In connection with this "limit of expenditure" question a great controversy has been carried on between the County Councils and the Local Government Board auditors, as to whether it is intended to limit the actual annual cash payments or to limit the total amount of the "proposals" adopted during the financial year, and, so far as the Author is aware, the question is still unsettled, one set of auditors holding one view and another set holding the other.

Since the passing of the Act the number of Urban Districts has been increased to 39. This has not been at all to the advantage of the roads now included in the urban areas, as in most cases, their total valuation is so small that it would be necessary to levy a prohibitive rate in order to maintain the roads in accordance with modern ideas.

The mileage of roads kept under constant maintenance by the County Councils is 18,307, at an average cost per mile varying from £30 in County Antrim to £10 in County Donegal. In Donegal, Monaghan, and Cavan there is a considerable additional mileage which is only repaired at intervals. To administer this mileage and expenditure there are eleven county surveyors and sixty-five assistants, together with three specially qualified assistants, viz. two in Antrim and one in Down. Nine of the county surveyors are existing officers—viz. served under the Grand Jury in their present counties—one was translated from one county to another, and one has been appointed since the Act came into operation.

The total expenditure by way of salary on this staff amounts to £15,232, or about $4\frac{1}{2}$ per cent. on the outlay. Except in the case of the three special assistants above referred to, no allowance is made to any of the surveyors or assistants for travelling expenses, so that the harder they work and the more efficient they are, the more their pockets suffer. To put it mildly, this is not much of an encouragement to a man as he grows older and his responsibilities increase, and it is not to be wondered at if things are sometimes allowed to slip.

Might the Author suggest that the members of the Irish Roads Improvement Association (who undoubtedly mean well, and have a useful function to perform) should bear this fact in mind the next time they consider some unfortunate county surveyor requires correction. It may be mentioned that this body have issued a number of very interesting and useful pamphlets on road maintenance, and it will interest their members to know that their work is undoubtedly bearing fruit in most unexpected quarters. Occasionally, however, if one is to judge by what one sees in print, the Association in question assume that where things are not what they ought to be, it is because the County Surveyors do not know any better, forgetting entirely that the real masters of the situation are the District Councillors, and that the County Surveyor has often to put up with material and methods which he knows to be bad.

In spite of the subtraction of the newly formed urban district mileage, the total mileage of county roads seems to be increasing, not so much by the making of entirely new roads, as by the ingenuity of District Councillors in discovering

"boreens" upon which, at some more or less remote period, a generous Grand Jury is alleged to have spent some public money.

At the present time the roads are maintained entirely under the contract system in seven counties, while in two counties both the Direct Labour and Contract systems are in force. Under the Contract system a person, who in ninety-nine cases out of a hundred is a small farmer, undertakes to supply the necessary material and labour required to keep a particular road in order, for a period not exceeding seven years, in accordance with a specification approved of by the District Council.

There are 10,222 such contracts in force in Ulster at the present moment, the average duration being for a period of three years.

When it is remembered that each of these contracts must be inspected at least four times each year, it will be seen that the time of the staff is pretty well occupied. In most of the counties the amount of competition for these contracts is extraordinary, and in the good old days the way in which prices were "cut" was past belief. To such an extent was this carried that frequently the idea of keeping the road in order appears to have been entirely forgotten, and many a man became contractor for roads which he had never seen, and never intended to see. The Author is happy to think that that state of affairs has pretty well disappeared, and public opinion, which in former days rather enjoyed the fun of seeing the county "done," has awakened to the fact that the fun has got to be paid for. In Antrim, about ninety miles of road are being worked by direct labour, while in Armagh a scheme embracing 493 miles came into operation during the month of April this year. There is undoubtedly a very strong prejudice in Ulster against direct labour. It is admitted that road contractors can make a handsome legitimate profit, in spite of the fact that very few of them possess the appliances, capital, or the business training necessary to carry out the work to greatest advantage. Why the general ratepayer, as represented by the District Councillors, should raise objections to turning the profit to his own advantage is mysterious. There is also the feeling that money spent in supervision is money thrown away (and admittedly the success of direct labour depends on efficient supervision), but why this feeling should exist, seeing that every successful farmer is a

living proof to the contrary, is equally mysterious. In some cases the explanation is that the majority of the District Councillors are relatives or intimate friends of contractors, but this by no means explains all the cases. While the Author cannot clear up the mystery to his own satisfaction, he is firmly convinced that a well-thought-out scheme of direct labour working side by side with the present contract system, would tend to economy, and would rapidly improve the condition of the roads in every county in Ulster.

When the Grand Jury Act, of 1836, was drafted such a thing as steam rollers or road machinery was never contemplated, and accordingly no provision was made for the purchase of anything of the kind. Although after its introduction in the towns, some Grand Jurors and County Surveyors were quite prepared to give steam rolling a trial, it was not until 1891 that a roller was introduced into county work. This was brought about by Mr. P. C. Cowan, now Chief Engineering Inspector of the Irish Local Government Board, but at that time, the County Surveyor of Down, who argued that as the Grand Jury was authorised to make use of tools for road maintenance, a roller was a tool, and could therefore be employed. Mr. J. H. Brett, in Co. Antrim, immediately followed suit, and in 1892 Mr. R. H. Dorman made a beginning in Co. Armagh. In 1896 South Tyrone gave it a trial. In every one of these cases, however, the rollers were only hired, and in every case the experiment met with tremendous opposition from the ordinary ratepayers, but was persisted in by the County Surveyors. So great was the opposition that it was strong enough after the election of the first District and County Councils to induce those bodies to refuse to vote any money whatever for steam rolling, and for almost two years after the Act of 1898 came into force no rolling was done in Ulster outside of the two county boroughs. However, the Act had provided the power to hire or purchase machinery of all kinds, and the County Surveyors, being of a persistent disposition, worried the Councils into giving the thing another trial. Now, the only county in Ulster which does not own rollers of its own is Co. Down, which prefers to hire all the rollers it wants. Even yet, however, the opposition is not quite dead, for only the other day the District Council of Limavady in Co. Derry declined by sixteen votes to fifteen, to ask the County Council to provide

steam rollers for the use of the contractors, but it is only a question of time till the opposition entirely disappears. There are now thirty rollers owned and worked by the County Councils, and fifteen rollers constantly on hire. In five county districts rolling is specified as a portion of the general maintenance contract, the contractors paying so much a day for hire. In five county districts special proposals for working rollers are passed, the contractors supplying material and labour, but paying nothing for hire of roller, while in two counties special proposals are passed to provide material and roll it in independent of the ordinary maintenance contract. The same section of the Act which authorises the ownership of steam rollers also enables the County Councils to own and work quarries, and in this particular the Author thinks he can claim to be the pioneer. Last year the Author's Council leased a quarry about 2½ miles from rail at Cookstown, and now raise and prepare the material—whinstone—used in all the important roads in the vicinity of Cookstown and Dungannon.

In both rural districts special proposals are passed to cover the cost of production, and we provide the material, either in the quarry or free on rail at the nearest point without direct charge to the contractors. Each contract provides that the contractor shall cart the material specified to his contract. In this way, all disputes as to quantity and quality of material are done away with, and a very considerable reduction in the cost of maintenance has resulted, as it is no longer necessary for a man to own a quarry of his own before he can tender to work a road. In Co. Armagh the County Surveyor has worked quarries for some years to supply material for roads put into his hands because contractors could not be got, and in County Derry (four) and Donegal North (two) quarries have recently been acquired, but have not yet been worked. In Armagh (one), North Tyrone (three), Cavan (three), Fermanagh (one), Monaghan (two), and Derry (two), the County Councils own and work a number (twelve) of portable stone-breakers, which travel round the country to break material for any contractor who hires them.

This arrangement has not been found to be an unqualified success, as the output of any breaker depends so largely on the way in which it is attended to. It is next to impossible to get the contractors to keep the machines going, added to which

there is the time lost running from job to job, and the difficulty of getting into and out of private quarries, etc.

However, it is quite evident that the Councils have realised the value of obtaining good material and of having it properly broken.

In addition to the county breakers, there are a considerable number of privately owned machines. While they are of great assistance to contractors, they are by no means beneficial to the roads, the natural tendency for the contractor being, of course, to get his material broken as fast as possible, without reference to the quality of the output. To a certain extent, this tendency is modified by the desire of the owner to keep his machinery going; but as most of these owners also own threshing machines, the season for stone-breaking is very short, and, rather than pass a job, the work is too often rushed. Very few of the private breakers are fitted with satisfactory screens, and the jaws are worked so long as anything in the nature of a rib is visible.

For so far the dust problem has not made itself prominently felt in Ulster. Undoubtedly it is bound to come, but it is to be hoped that when it does appear some satisfactory method of dealing with it at a moderate cost will have been perfected. For dealing with the winter mud, three counties have provided horse brushing machines and hand-scrapers, to be hired to contractors, while as a matter of course these machines are in use in the direct labour areas. There is a good deal of difficulty in arranging for the hiring of horse machines over such large areas, and in spite of the fact that it is slow and tedious, the Author considers there is nothing to beat good systematic cross-brushing by hand.

Under the Grand Jury Act there was no provision for anything in the nature of main roads, but all roads upon which the Post Office had the mails carried in wheeled vehicles were designated "post roads," and half the cost of their maintenance was defrayed by the county at large. Under the Act of 1898, the County Councils were empowered to (and doubtless it was intended that they should) declare some roads main roads, in which case half the cost of maintenance would be defrayed by the county at large, the various districts in which the roads were situated paying the other half.

Unfortunately, however, no attempt was made to give even an outline definition of what would entitle a road to be classed as

a main road; and more unfortunately still, before any declaration could become operative, it was necessary to satisfy each of the District Councils concerned, with the result that it was found to be utterly impossible to arrive at any sort of agreement. Until the then existing contracts on "post roads" expired, these roads continued to be treated as main roads. The attitude taken up by most of the District Councils was, that they should receive as much from the county as they each contributed, irrespective of the nature of the roads and the traffic—a thing utterly unattainable in practice. In despair, some County Councils declared all their roads "main roads," while others declared they would have "no main roads," and either of these declarations produced comparative peace.

In four counties it was decided to have main roads, but it was necessary in each case to refer the matter to the Local Government Board and have the matter settled by them. The declarations are subject to revision at intervals of five years and the result of the first revision is that at the present time only two counties have declared main roads, while the other seven have declared no main roads. For the sake of the more important roads this is to be regretted, as there is in some cases a tendency to cut down the expenditure on these roads to provide funds for maintaining very unimportant bye-roads.

An interesting paper on the subject of main roads by Mr. R. H. Dorman will be found in Volume XXII. of the "Proceedings of the Association of Municipal and County Engineers."

In conclusion, the author would like to make a brief reference to a few matters which cause infinite trouble and in regard to which modifications are much needed in the interests of all concerned. Before doing so, however, he desires in the strongest possible way to bear testimony to the remarkable success with which the County and District Councils have carried out the work devolving on them. When the Local Government (Ireland) Act, 1898, became law those who were in the best position to form an opinion, regarded it as a dangerous experiment, and the proceedings of many of the District Councils for the first year certainly tended to confirm that opinion. However, that has entirely changed, and at the present time, with very few exceptions, the County and District Councils are working harmoniously and progress is being made—it may not be rapidly enough to please everybody—but still it is progress. This state of matters

is largely due to the wisdom with which the Councils without exception selected the best possible men for the chairmanship; to the ability and devotion of the clerks of the District Councils, to whom the work was absolutely new; and to the tact of the county secretaries. As to the part played by the county surveyors it is not for the Author to speak, but they have certainly had a hand in it.

First there is the traction engine trouble in the neighbourhood of the larger towns which we are at present unable to regulate effectively.

Then there is the proper maintenance and improvement of the main lines of communication, many of which are very weak and unnecessarily crooked. This should be taken entirely out of the hands of the District Councils and entrusted to the County Councils. Then there is the question of regulating the width of tyres of heavily loaded carts, the present standard type of vehicle being outrageously destructive. Then, in connection with the contract system, there is the difficulty of dealing promptly and effectively with the negligent contractor, and in connection with the direct labour schemes there is the difficulty of complying with the regulations laid down by the Local Government Board, more especially in the matter of payment of the men employed in schemes of small extent. Again, at the present time the control of the Local Government Board is almost entirely confined to matters of finance. If it could be extended to cover efficiency in the method of maintenance of the more important lines of communication, it would be an immense benefit.

The Author is aware that to do this it would be necessary to appoint a staff of inspectors, but he is convinced that the results would more than justify the expenditure. Finally, there are the more personal matters, such as the amount of time county surveyors must spend at meetings, and in their offices doing mere clerical work, the only object of which, if it serves any purpose at all, is to minimise the work of the Local Government Board auditors.

At present the Author does not exaggerate when he says that quite 60 per cent. of the county surveyor's time must of necessity be spent indoors, when it could be much more profitably employed outside. Another difficulty—and one which it is hard to see how to avoid—is the way in which applications are made by

District Councillors for work, with the object of trying to curry favour with the electors. The District Councillors themselves are quite well aware that the work applied for cannot pass (nor do they intend that it should), but in order to demonstrate their activity they make the applications. Occasionally, even they go the length of passing proposals (which they know the County Council must reject) in order to discredit that body.

The hardship is that the county surveyor must assume every application to be *boná fide,* and must secure all the information needed to deal with it as a possible proposal. As a rule, the District Councils take on sufficient work at the January meeting to practically exhaust the available funds for the next financial year, nevertheless they continue to receive applications for the remaining three meetings.

As an example, one of the Author's District Councils left themselves a balance of £20 after the first meeting, and received applications at the second meeting amounting to over £1000. On the face of it, it would appear to be a simple thing to get rid of the £20 and have done with it, but in practice it is not. Each Councillor feels called upon to advocate the claims of his particular locality (and why not?), and next day we read in the local newspapers—"the meeting terminated after a sitting of five hours"! Lest the same should be said of our meeting, the Author will conclude by thanking his brother county surveyors who have supplied him with the detailed information necessary for the preparation of this paper.

PORTADOWN AND BANBRIDGE WATER SUPPLY.

By R. H. DORMAN, M.Inst.C.E., County Surveyor, Armagh.

Previous to the inception of the present works, many schemes were suggested for supplying these towns with water.

About the year 1885, Mr. Henry Smith, the County Surveyor for North Down, and Mr. Macassey, of Belfast, propounded a scheme for supplying Lurgan, Portadown, Banbridge, Downpatrick, and other places with water, at an estimated cost of £104,000, from the eastern slopes of Slieve Croob mountain, situated in the County Down. This scheme, however, fell through owing to the impossibility of inducing the several towns included to take joint action in the matter. Subsequently the Portadown Urban Council called in the Author of this paper and Mr. Henry Shillington, C.E., to investigate the various sources from which a supply could be obtained for Portadown, and they reported on the following schemes amongst others :—

1. Obtaining a supply from Marlacoo Lake, situated about eight miles from Portadown, by means of a 12-inch pipe calculated to discharge 400,000 gallons per day, and the construction of a service reservoir and filter beds on elevated ground at Killycolmain, about one mile from the town.

2. Taking a supply from the River Bann at a point about two miles above the town, building a pumping station at Levaghery, and pumping through a 7-inch rising main to Killycolmain.

3. Taking a supply from near Ardmore Point in Lough Neagh, and pumping through a 10-inch main also to Killycolmain.

4. Taking a supply from the Lurgan Urban Council by means of a 10-inch main laid from Church Place, Lurgan, to Portadown, a distance of five miles.

Ultimately Messrs. Dorman and Shillington reported in favour of the River Bann scheme, and preliminary steps for the carrying out of this project were taken. The scheme, however, was not a popular one. It was felt that to extract water from a river, for drinking purposes, which was polluted by the untreated sewage of Banbridge and Gilford, a few miles up the river from the proposed intake, would not be a suitable source of supply.

At this time the inhabitants of Banbridge were also feeling the necessity for obtaining a good supply of water—proposals for obtaining a supply from the Bann, and also from an underground source, had already been considered, but neither of these schemes were considered satisfactory. Eventually the Portadown Urban Council called in Mr. J. H. Swiney, Belfast, to report on the various schemes which had been propounded, in conjunction with Mr. Dorman, and these engineers reported in favour of the Bann scheme, with a suggestion, however, that it might be possible, if Banbridge joined hands, to obtain a supply from the Shimna River, situated in the Mourne Mountains. This suggestion was immediately taken up, and the engineers were instructed to report on the feasibility of obtaining a supply from this source. In March, 1900, their report was issued strongly advocating the head waters of the Shimna River for supplying both Portadown and Banbridge with water, and submitting figures which showed that not only in the matter of the quality of the water, but also in the matter of cost per 1000 gallons, this scheme was far superior to any yet submitted for Portadown.

On consideration of the report the Portadown Urban Council recognising the great advantage to their town of obtaining a copious supply of unpolluted water, and on being assured by the Engineers that there were no engineering difficulties in the way, decided to invite Banbridge to co-operate with them in carrying out the project. To this the Banbridge Urban Council agreed, and both Councils then applied to the Local Government Board to constitute them a Joint Waterworks Board under the Irish Public Health Act. In January, 1902, Mr. Cowan, Chief Inspector to the Local Government Board, held an inquiry into the merits of the scheme, and on his report the Local Government Board granted the order constituting a Joint Board for the two districts, which was subsequently confirmed by

Parliament. It became, however, necessary to obtain a further Provisional Order to enable the Joint Board to obtain possession of the land required for the carrying out of the scheme, and after considerable opposition before a Committee of the House of Commons, this order was confirmed in 1903.

The chief features of the scheme are as follows:—

The acquisition of a Catchment Area in the Mourne Mountains at an elevation varying from 900 to 2300 feet above sea level, and the interception of the head waters of the Shimna River collected off this catchment area by means of a dam thrown across the river at a place known as the Deer's Meadow, in Foffanyreagh, and the construction of a storage reservoir to hold 75,000,000 gallons, the laying of a 10-inch main from this reservoir to Drumnahare, situate about $1\frac{1}{2}$ miles from Banbridge, where a service reservoir has been constructed to hold 300,000 gallons for the supply of Banbridge. From here a 9-inch main conveys the water for the supply of Portadown to Drumclogher, about $1\frac{1}{4}$ miles from Portadown, where a second reservoir to hold 1,000,000 gallons has been built.

The further works included in the scheme of course include the laying of the usual service pipes in the towns of Portadown and Banbridge, with all necessary fountains, hydrants, and scours, etc.

Catchment Area.—The catchment area embraces an area of about 943 acres, situated for the most part on a granite formation, but in parts on silurian rock. There is not a single habitation on it, and it is composed of steep and barren slopes of very little value even for sheep grazing, so that the supply is unpolluted from animal sources, and it would, therefore, be practically impossible to get a purer supply anywhere. As regards the quantity available, the average mean rainfall over the area is estimated at 70 inches, but in order to be perfectly safe, the mean rainfall was assumed to be only 55 inches, which gives for three consecutive dry years 44 inches, and allowing 12 inches for evaporation, allows 32 inches as the quantity available, which, from 943 acres, would give a supply of 1,886,000 gallons per day. As the present population to be supplied is only about 15,000 however, and the consumption estimated at 30 gallons per head, or 450,000 gallons, it is evident that the supply should be ample for many generations to come.

It should here be mentioned that the Joint Board have

acquired all rights to the water derived from their catchment area, the only proviso inserted in the Provisional Order being that the Board should allow the town of Newcastle to take a supply from this source on terms to be agreed on, if at any time they desired to do so.

Newcastle, however, is not likely to avail itself of this privilege as there are other sources more convenient to Newcastle from which an abundance of equally good water could be obtained for that town.

Storage Reservoir.—Previous to obtaining the provisional order, borings were sunk along the approximate centre line of the proposed puddle trench, but owing to the number of large boulder stones met with, and the danger of mistaking a large boulder for the solid rock, it was thought advisable to sink a shaft down to the rock on the eastern side of the valley; further shafts were also sunk previous to tenders for the work being invited, and the position of the rock was thus definitely located right across the valley.

Embankment.—The embankment rests for the most part on boulder clay, with a large admixture of stones and of gravel in the lowest part of the valley next the river. It is being constructed of earth, etc., with a puddle core. The total length of the embankment will be about 800 feet; it will be 15 feet at top, with side slopes of 2½ to 1 and 2 to 1; its greatest height from the bed of the stream will be 48 feet. Prior to its commencement all soil and vegetable matter was removed off the site, and all gravel on the upstream side of the puddle trench.

The material used in the bank consists for the most part of a bluish boulder clay, and as the work proceeds the pick of this clay is used for selected material, while that containing a large proportion of stones, peaty matter, or gravel is used on the downstream portion of the bank. The material is tipped from small waggons, containing about 1 cubic yard each, and is deposited in 2-feet layers with a slight slope towards the centre of the bank; the clay is of such a nature that it dries very quickly when placed in position, and forms a very solid bank, so that no special means have to be taken in order to consolidate the material. The selected material in each side of the puddle wall will be 4 feet 6 inches at top, with a batter of 1 in 2 to ground level.

The top of the bank will be at the level of 959 feet above

Ordnance Datum. The inner slope will be covered for the upper one-third with hammer-dressed pitching 12 inches thick on 12 inches of shingle, the middle one-third with pitching 9 inches thick on 9 inches of shingle, and the bottom with a layer of shingle 18 inches in depth.

Centre Core.—It was at first proposed to construct that portion of the core below the natural ground-level with a tongue of concrete 3 feet thick, swelled out at the top so as to form a junction with the puddle, which would form the core through the made bank; but there being some doubt with regard to the practicability of putting in such a thin wall of concrete which would prove impervious throughout, and, as if the wall was made much thicker it would prove as expensive as puddle, it was decided to rely on the material usually adopted in this country in such positions. The puddle will be carried to within 2 feet of the top of the bank, where it will have a width of 6 feet, widening out with a batter of 1 in 16 to ground-level, from which point to the bottom of the trench it will diminish to a finished width of 5 feet. The puddle is carried well into the solid rock right across the valley, the trench being 46 feet at its greatest depth, the average being 26½ feet below the surface; but two springs were met with in excavating the trench, and these were easily dealt with, the only serious difficulty in connection with this portion of the work being the large quantity of broken and fissured rock which had to be passed through before sound rock was met with.

As it was anticipated that some subsidence of the puddle trench would occur after completion, and that consequently a leakage would take place through the space so left between the under side of the wing walls of the waste weir and the top of the puddle, it was decided to carry up a concrete pier from the puddle trench on which that portion of the wing wall next to the main embankment crossing the puddle trench might rest; 7 feet by 5 feet at bottom by 3 feet by 5 feet on top, and about 34 feet in height, it is dovetailed on two sides to make a good joint with the puddle, and on the other two sides there is a projecting tongue which bonds the pier into the solid ground. It was not considered necessary to make any provision for possible subsidence under the wing wall of weir on the east side next the mountain. The puddle required so far has been obtained within the catchment area at a distance of about one mile from

the trench; it is a strong gravelly clay, and before being deposited in the trench the larger stones are picked out and it is turned over and watered, until it is brought to the proper consistency, when it is placed in the tipping waggons and run down to the trench; some trouble was experienced in keeping the trench free from water when the puddle was being deposited.

The puddle, when it is sent down, is usually on the soft side, and packs well, little cutting or working being required in the trench, it being only necessary generally to spread it off in thin layers as it is dropped in.

Blasting on a small scale was allowed in getting out the rock in trench, but care was taken that the bed rock was not damaged in any way by this operation.

Outlet Tower.—The tower will be 52 feet high over the assumed surface of rock, circular on plan, and 4 feet 6 inches diameter inside; it will be connected with the main embankment by means of a lattice girder gangway in two spans of 39 feet each, both the tower and the intermediate pier carrying the gangway will be built of concrete. Both the scour pipe, 15 inches diameter, and the supply pipe, 10 inches diameter, are carried from the tower under the embankment and are embedded in concrete resting on the solid rock. Where the pipes cross the puddle trench two stop plates are leaded on to the pipes, and the concrete is carried down to the bottom of the puddle trench. The scour pipe is fitted with a bell-mouth, in front of which will be fixed a wrought-iron grate 4 feet 3 inches by 4 feet, consisting of $\frac{5}{8}$-inch bars spaced $1\frac{1}{2}$ inches apart. In the tower there will be three 10-inch inlets at 10, 20, and 30 feet below top water level connected with the supply pipe, each provided with a sluice valve, spindle, and headstock.

Bye-Channel.—This channel is carried along the mountain slope on the eastern side of the reservoir. It is 20 feet in width at bottom, with side slopes of $1\frac{1}{2}$ to 1. The upper portion of the bank between the channel and the reservoir is formed of the material excavated in making the channel, and consists of boulder clay and an admixture of peat, which, no doubt, is not quite impervious, but it is not thought that the slight leakage through the bank will be of any consequence. The floor and sides of the channel are pitched with rough, hammer-dressed granite blocks brought from a quarry opened on the mountain side, and the joints are packed with small spawls, chips, and

gravel. This pitching has, no doubt, a rather rough and uneven appearance, but it is good strong work. It has a fall of 1 in 528 all the way.

Waste Weir.—The waste weir is 50 feet in length, the crest being at the level of 594, or 5 feet below the level of top of embankment when completed. Both weir and wing walls are built of concrete. The weir is surmounted with a lattice-girder gangway, 3 feet 6 inches in width, secured to wing walls at ends by means of Lewis bolts. Four wash-boards, 12 inches by 3 inches, fitted with straps and lifting-chains, are provided for raising water-level in reservoir when desired.

Waste Channel.—This channel is 12 feet in width, and has a gradient of 1 in 9. The side walls are formed of concrete, 18 inches thick and 3 feet in height, the floor is formed of rough granite blocks laid with wide joints which have been filled in and grouted with fine concrete. To prevent any creep of water under the pitching curtain, walls of concrete, 4 feet in depth and 2 feet in width, have been put in at intervals across the channel. The lower end of the channel is stepped so as to form shallow water-pillows to retard the velocity of the water, and at the foot there is a breakwater-pool from which the water discharges into the old river-course.

Inlet.—An embankment will be constructed across the stream, by which means the water can be sent down the bye-channel or it can be led into the reservoir as required by means of a penstock fixed in concrete side walls with concrete forebay, tailbay, etc.

Main Pipe Line.—The length of the pipe line from the storage reservoir to Drumclogher reservoir is $23\frac{3}{4}$ miles. Of this length 15,365 yards are 9-inch pipes, $\frac{9}{16}$ inch thick; the remainder are 10-inch. Of the 10-inch pipes 55 yards are $1\frac{3}{16}$ inch thick, 9182 yards are $1\frac{3}{8}$ inch thick, 1649 yards $\frac{3}{4}$ inch thick, 835 yards $\frac{11}{16}$ inch thick, and 14,702 yards $\frac{9}{16}$ inch thick. The pipes are laid with a minimum cover of 2 feet 6 inches, with a fall from each air-valve to the nearest scour, boning-rods being used to obtain as far as possible uniform gradients from point to point.

The pipes were laid with turned and bored joints with 10 per cent. of lead joints to allow for expansion and contraction. All specials had lead joints. In addition to the ordinary turned and bored joint the pipes on the heavy section, comprising all pipes over $\frac{9}{16}$ inch thick, had the joints run with

lead and were set up in the ordinary way after the pipes had been driven. These pipes, in addition to being turned and bored, had a space left inside socket for lead joint.

Each pipe, before it was laid, was well brushed out, the turned and bored parts carefully cleaned, and, when not lead-jointed, brushed over with a coating of neat Portland cement, each pipe being driven home by another pipe used for the purpose. Scour valves were placed in every hollow, with a line of pipes to nearest water-course. In the case of the 9-inch main, the scours were 3 inches diameter, and for the 10-inch main, 4 inches diameter. Air-valves were placed on every summit—single air-valves on the 9-inch main and on the light section of the 10-inch, double air-valves on the heavy section of the 10-inch. Special provision was made to permit the main to be scraped in the future, in case incrustation should take place, hatch-boxes being fixed at each reservoir, and seven others along the pipe line to allow the insertion and removal of the scraper.

At Edenagarry, situated about 9 miles from the Storage Reservoir, at an elevation cut by the hydraulic gradient, a relief tank, with a capacity of 100,000 gallons was constructed of concrete; while at distances of 12 miles and 16 miles from the reservoir blow-off towers were erected. No serious difficulties were met with in the laying of the pipe line, and considering the very rugged and irregular cross-country route traversed, less rock was met with than was expected. The only two obstacles met with that the Author need draw attention to were the crossing of the River Bann at 4½ miles from the Storage Reservoir, and the crossing of Kernan Marsh, at 17 miles from the same point. At the point where the pipes cross the River Bann, in Ballycoshone, the head of water amounts to over 600 feet, while one side of the river bank rises very abruptly to a considerable height, so that great trouble was required in this portion of the work, and special means had to be adopted for anchoring the pipes on the steep bank on the left-hand side of the river. The pipes across the river are in duplicate, and are laid on concrete; in each bank are chambers, built of concrete, into which these pipes are brought and connected with the main by means of breeches pipes. In the chamber on the right bank are fixed a hatchbox, with a scour leading to the river, and other necessary controlling sluices; in the chamber

on the left bank is placed a double air-valve, as well as a sluice-valve on each of the branches passing under the river. The pipes on the left side are anchored into the bank by heavy blocks of concrete surrounding them, and carried well into the solid ground.

Kernan Marsh Crossing.—A foundation for the pipes was formed by driving two rows of round larch, 6 inches minimum diameter, to a firm bottom, two pairs to each 9-foot pipe, and fixing thereon railway sleepers, 10 inches by 5 inches, creosoted, the top of same being brought to a true level for the pipes. The surface of the marsh along the pipe-line, and for a width of about 16 feet, was then covered with a thick layer of fascines, and on this was formed an earthen embankment to cover the pipes, 4 feet in height, with a top width of 3 feet, and side slopes of 1½ to 1. At one side of the marsh, a culvert, 18 inches square, had to be constructed under the pipe line; it was made of 1½-inch deal, tongued and grooved, and strapped with strong hoop-iron. So far this work has proved satisfactory, and has required little attention.

Service Reservoirs.—The reservoir at Drumnahare has a capacity of 300,000 gallons; it is 80 feet by 80 feet on plan at top, and 47 feet 6 inches by 47 feet 6 inches at bottom with rounded corners. It is 15 feet in depth with a maximum depth of water of 12 feet. Both floor and side slopes are composed of concrete (7 to 1) rendered with cement mortar (1 cement to 2 sand). The inlet pipe discharges into a small circular well from which a 12-inch half-round pipe is laid down slope of reservoir. The outlet pipe laid in concrete under the embankment is 11 inch diameter as far as the Deacon Meter Chamber in which it branches, one branch, 9 inches diameter, leading to Portadown, and the other 6 inches diameter forming the supply pipe to Banbridge. This pipe is fitted with a bell mouth and gauze movable screen which is worked from a gangway resting at one end on the bank of the reservoir, and at the other on a concrete pier carried up from the floor of the reservoir. The reservoir is also supplied with a 6-inch scour and overflow, and with a bye-pass 9 inches diameter leading round the reservoir, by which means the two towns can be supplied if at any time it is required to cut off the water from the Reservoir.

Drumclogher Reservoir.—This reservoir is also constructed of concrete, it is 118 feet diameter, total depth 18 feet 6 inches,

and maximum depth of water 16 feet; the concrete in floor is 12 inches thick, and the circular wall 4 feet 6 inches thick at bottom and 2 feet at top; it is all rendered with cement mortar as in the case of Drumnahare reservoir. The inlet and outlet are much the same as described for Drumnahare, the supply pipe leading to Portadown being 10 inches diameter, and laid in concrete as far as meter chamber.

Meters.—There are three Venturi meters, one on the 10-inch main immediately below the storage reservoir, and one on the inlet to each service reservoir, while a Deacon meter is fixed on the supply pipe to Banbridge, and a similar meter at Drumclogher on the supply pipe to Portadown. The Venturi meters are capable of measuring the flow from 2000 to 40,000 gallons per hour, and for dealing with large volumes of water this form of meter appears to be the most suitable. The chief advantages they possess over other meters are: (1) There are no moving parts in contact with the flowing water, and foreign matter carried along with the water does not cause any injury; (2) There is perhaps less loss of head than with any other meter; (3) They are guaranteed to register within 2 per cent; (4) The registering machinery is above ground, and it is therefore always open for inspection. The recording instruments in connection with these meters take weekly diagrams, showing the rate of flow at any time, and are also fitted with a counter-recorder which registers the total amount of water passed through the meters.

The present temporary supply to Portadown and Banbridge (the storage reservoir not being yet completed), is sometimes of a fluctuating nature, and the meter in Banbridge has in consequence proved very useful, the caretaker by turning all the water coming from the catchment area through his meter can see by inspection the total quantity available, and can then regulate his valves so as to give a proportionate amount to each town.

The recorders at Portadown and Banbridge are placed in the caretakers' houses, but the levels at the storage reservoir were not suitable for this, and a small detached building had to be erected for the meter there. This meter has just been put in, and diagrams are now being taken to determine the amount on the main through leakage.

The town services call for no particular remarks, the usual

trouble was, of course, experienced in laying the pipes through streets intersected with gas-pipes, sewers, old stone drains, etc., but no exceptional difficulties were encountered, the service pipes vary from 8 inches to 3 inches diameter, and street fountains and hydrants have been put in where required.

The works above described are, perhaps, comparatively unimportant, but they represent great courage and enterprise on the part of the representatives of two small but prosperous towns, who joined together and determined, in the face of unknown difficulties, to endeavour to supply their towns with an abundant supply of pure water from a distant source. Fortunately, no serious obstacles have occurred so far in the carrying out of the project, and as the remainder of the work is practically all above ground, no great difficulties are now likely to occur.

The chief credit in connection with the undertaking belongs to Mr. J. H. Swiney, M.Inst. C.E., who originated the project, and to Mr. C. Johnson, J.P., the Chairman of the Joint Board, while Messrs. Collen Brothers, contractors, have to be congratulated on the satisfactory and expeditious manner in which they laid the 24 miles of main, the service pipes in the two towns, and constructed the service reservoirs at Drumnahare and Drumclogher.

The work of constructing the storage reservoir is proceeding rather slowly, but it is not work that can be rushed through, and in the capable hands of Mr. Graham, the contractor, it is hoped that it may be completed before the end of the current year.

The Author cannot conclude without expressing his appreciation of the efficient manner in which Mr. G. Mitchell, one of our Associates, and Mr. H. Bell have discharged their duties while acting as resident engineers on the works.

The following notes with reference to the passing of the scrapers through the main pipe are supplied by Mr. H. Bell, one of the Resident Engineers engaged on the Works.

To make certain that the pipes were clear inside, and that there was no obstruction which might interfere with the flow or with scraping operations in the future, if necessary, it was specified that the contractors, before completion of contract, should pass a 10-inch scraper through the main from Foffany storage

reservoir to Banbridge service, and a 9-inch scraper from Banbridge to Portadown service. After filling the service reservoirs and charging up all distribution pipes, the passing of the scraper through the main was commenced.

As the men were in Banbridge at the time, and the sections between the hatchboxes were shorter, this was the part of the main done first.

On June 25 the scraper was put into the 9-inch hatchbox at Banbridge reservoir, and started round the bye-pass with the flow from the temporary supply. After proceeding about half a mile it stopped, as a good deal of water was getting past the scraper, and it was found necessary to turn on the water from the service reservoir, which drove the scraper to the next hatchbox with only one other stop for a few minutes. The scraper brought out at the hatchbox a stone 6½ inches by 5½ inches by 3 inches, and two strips of lead cut off from the pipe, which had been run in at some joint. One was 17 inches by 1 inch by ¼ inch, the other 6 inches by 3 inches by ¼ inch.

It was probably these last that caused the stoppage.

The 10-inch scraper was then put into nearest hatchbox to Banbridge on 10-inch main. It got lost passing under public road close to Banbridge reservoir, as a horse came along the road, and owing to the noise made the scraper could not be heard, and during this interval it got stuck. Owing probably to sudden stoppage, as it was now moving rapidly, two pipes behind burst and had to be replaced. The scraper was located by sending a good flow through the pipes and carefully searching the ground with the stethoscope. When cut out it was found that the scraper had two pieces of wood, one 2 feet by 4 inches by 2 inches, the other 9 inches by 2 inches by 2 inches wedged between it and the sides of the pipe. After the main was made good the scraper was again sent through, stopping a little further on than where first cut out and bumping for a little, finally bringing up a piece of lead about 3 lbs. weight.

Going back to the 9-inch main, the scraper was passed through the second section from Banbridge Reservoir, and had to be cut out on three occasions through lead having been run in at joints. Two of these indicated gross carelessness in running the joint, the weights of lead inside pipe being respectively 32 lbs. 10 oz., 5 lbs., and 25 lbs. This lead, of course, was not in a lump, but had run along the bottom of the pipe.

The passing of the scraper through the third section of the 9-inch main led to a very interesting burst pipe. The scraper had passed this pipe about 100 yards, when a circular piece, about ¾ inch diameter, was blown out of the pipe on the scraper stopping. On examination it was found to be honeycombed rather badly where the piece was blown out, and yet this pipe had stood the test on the works in England and the full pressure of the main up to that time. The scraper had to be cut out once on this section owing to some road-metal which had got into the pipes.

On the last section of 9-inch main the scraper had to be cut out once, as some stones stopped it at a bend.

The work on the second section of 10-inch main above Banbridge was rather uninteresting, the only incident being that the scraper struck some obstruction going up a hill, and stopped. The sluice-valve behind was shut and a scour opened, which caused the scraper to come back a few yards downhill. On putting on the pressure again it took the obstruction with it, when it was discovered to be a piece of wood 2 feet 6 inches by 6 inches by 3 inches.

On the third section of the 10-inch main the scraper had to be cut out once, owing to the fact that 26¼ lbs. of lead had been run in at a joint. The scraper got lost on this section, owing to some of the men with instructions turning on the water to the scraper on a wet day with a strong wind, when, of course it was almost impossible to follow the scraper, owing to the noise of the wind and rain.

They assumed it was stuck where they last heard it, and went off home. On trying to find if it was there the next day with the stethoscope, it could not be detected. As there was the chance that it might be anywhere along the two miles intervening between that point and the next hatchbox, the 9-inch scraper was put in, and followed so as to find if the other was stuck. However, on the Storage side of Edenagarry Relief Tank the 10-inch scraper was found by a man placed ahead. The 10-inch was taken round the bye-pass at the Tank, and driven with the water in the Tank to the next hatchbox. The scraper brought out on this section 6 small stones and a piece of wood.

As there appeared to be something wrong with the top section, extending from the Storage Reservoir to the Bann

Crossing, this was gone to next, and the results obtained on it repaid the trouble expended on the whole line. It was a rather long section, being over 4¾ miles between the hatchboxes. Two ordinary cut-outs were necessary on it, one caused by lead run in at a joint, the other by a piece of pipe sticking out from the side, where it had been caught in the driving of a turned and bored joint. A third cut was made, although the scraper had not been stopped, and was caused by the following circumstances. About 1½ miles from the storage reservoir, the scraper could be distinctly heard to strike some large obstruction, and then come on, driving it ahead. A little time afterwards, the obstruction appeared to have got ahead, as the men following it each thought that they heard the scraper, there being as much noise at one place as the other, although sometimes 100 yards apart. Coming to Loughanlea Hill, the scraper overtook the obstruction, and they commenced to ascend the hill together with short stops at intervals. As it would have been dangerous to let them go down to the heavy section, they were stopped on the top of the hill. On the pipe being opened, it was found that ahead of the scraper, and having been driven by it for presumably three-quarters of a mile, were several large stones, evidently maliciously placed in the pipe. One was roughly spherical, 8½ inches diameter, another 12 inches by 5 inches by 5 inches, and a number of others not quite so large, together with a steel jumper about 3 feet by 4 inches long, the total weight of stones and jumper aggregating 120½ pounds. How the scraper, driving these ahead uphill, got round a bend, is rather a mystery.

The scraper was then put through the remaining section from the hatchbox at the Bann Crossing, the double line necessitating its going through twice. Nothing noteworthy occurred in this section, except that on the first occasion it went too fast to be followed all the way, owing to the great pressure.

The work was completed on August 24, two months after it was commenced. During this time scraping was not engaged in constantly, as the towns having to be kept supplied, Saturday was usually reserved for other work. A good deal of finishing up of work was done, as well as making good the bursts on the main. Time was lost to some extent in moving about from section to section. The scraper was sent through

the main again if pipes had to be replaced behind it. A great disadvantage was the fact that once when the work had to be carried out on the storage reservoir side of Edenagarry relief tank, there was no supply of water to keep the pipes full, the only means of getting a good flow to drive the scraper being to shut down a sluice-valve and charge up the pipes with the fluctuating temporary supply, which, owing to the dry season, was sometimes very small. The valve being opened, the water backed up behind it was utilised, until, as occasionally happened, too much was getting past the scraper in proportion to the flow, when the operation had to be repeated.

In all the scraper was cut out ten times in the 23¾ miles, six of the cut-outs being caused by lead run in at joints, and the remainder by obstructions in the pipe. Of these last four one or two could, perhaps, have been avoided, but it would have been at the risk of injuring the pipe line.

No trouble was experienced in getting the scraper through the few bends used in the main.

While passing the scraper through the main four of the 10-inch and five of the 9-inch pipes burst. Three lead joints required slight restaving, and one leaking turned and bored joint was run with lead.

Of the pipes which burst, one was a defective casting and the other had probably got injured previously in transit or otherwise, the rust on a portion of the cracks showing that it had previously existed, in some cases halfway through the metal.

DISCUSSION.

Mr. J. Cartwright: Mr. Dorman's paper on the Portadown and Banbridge Water Supply Works particularly claims my personal interest, dealing as it does with a class of work which has of late been largely engaging my attention. With regard to the clause of the specification which provides that the contractor who lays the mains, shall, before receiving his final certificate, satisfy the engineer that the pipes are "clear"—by passing a scraper through the main—this proviso is an excellent one, for it frequently happens in practice, that despite every precaution, foreign substances get into the pipes during laying operations. Only last week I discovered a piece of timber over

a foot in length obstructing one of my mains, which had been in use for seven years, and during this period the piece of timber had doubtlessly been floated about until it had eventually got wedged, causing an obstruction that led to its discovery. I should like to take this opportunity of expressing the pleasure I have derived from attending these meetings. We are indebted not only to the gentlemen who take the trouble of preparing papers, and who afford us the invaluable opportunities of inspecting their works, but our gratitude is also due to the Association, which is the means of bringing us together, and establishing fraternal relations amongst us, which otherwise would not exist. I regret that of late years I have not been able to attend the meetings of the Association as frequently as I formerly did, but I do so whenever I can, and I cannot, speaking as perhaps the oldest member present to-day, too strongly urge on the young members of the Association the advantage of availing themselves of the practical opportunities afforded at these meetings and visits; and I would recommend them to attend as often as possible.

Mr. R. H. Dorman: Our thanks are due to Mr. Leebody for the very lucid manner in which he has described the principles of county road maintenance in Ireland. By the Act of 1898 the amount of money which any particular district council can devote to road maintenance in any year has been fixed at a figure, being 25 per cent. in excess of the average annual expenditure during the three years before the passing of the Act. Mr. Leebody says he "has not yet met anybody who could explain how these certified figures were arrived at, but having got them, they are what we have to work upon." There is no doubt the county secretary could give the figures for any county or barony, but for the newly formed districts it would be impossible for any one except the county surveyor to give them. The total amount available for road maintenance is 348,218*l.*, which I take it is the limit which can be expended, and as approximately 337,857*l.* is expended, there is only a balance of 5361*l.* to go upon. I am surprised at these figures, because in my own county of Armagh we have not come anywhere near to the limit. We are expending about 30,000*l.* out of a total of 35,000*l.* (Mr. Leebody: We ought to get better results for the money.) I quite agree with you. The present system of road maintenance

in Ireland is a corrupt and extravagant system. This system of writing a specification and then throwing the whole responsibility for the maintenance of the roads on contractors for a period of one to seven years, gives them every opportunity of swindling the county and hoodwinking the county surveyors. It is a corrupt system, and I could give you hundreds of examples of the bad results of it. I will give you one instance. A contractor wrote that he had put out the proper complement of stone. I sent my assistant to measure it, and he found there was not the full complement. The contractor promised to make up the proper quantity of stone, and he afterwards wrote, saying he had spread it on the road. I took it upon myself to go and inspect the road. The stone was not on the side of the road, and had not been spread on the road. I pursued my inquiries further, and found heaps of stone in a quarry, which the quarry owner said did not belong to him; and heaps of stone in farmyards and other places, and the farmers said they did not know where they had come from. As a consequence I could not, therefore, take proceedings against the contractor, as I could not get any one to give evidence. The farmer, who is usually the contractor, is generally a poor man, and he has to go to a money-lender and borrow the money at 40 per cent. interest, so that when you take the contractor's and the money-lender's profit into account, you could save at least 20 per cent. on the road, so that out of every 20,000*l*. expended on the roads 4000*l*. of it is lost to the county. As to the number of Urban districts I quite agree with Mr. Leebody that there are too many of them. Some of these districts only pay their Urban surveyors about 5*l*. a year for the work he has to perform. Mr. Leebody refers in his paper to the Irish Roads Improvement Association. That is a body I very much favour. I believe they are doing a great deal of good. There are members of that Association who are rough on the county surveyors, and they get up at their meetings and make remarks which would lead one to imagine that they know more about roads than the county surveyors. Further on Mr. Leebody says, "The real masters of the situation are the District Councillors." I quite agree with him. It is a great blot on the Act, which should be remedied at the first opportunity, because the County Council is the body which is responsible for the roads being maintained in reasonable repair. The County Council should have full power to increase the

sum of money to be spent to make it sufficient for the proper maintenance of a road. The County Council has a remedy under the Act. It can appeal to the Local Government Board, who can hold an inquiry. But the County Council naturally shrink from a quarrel with the local authorities, and the expense of an inquiry is a heavy matter. Mr. Leebody refers to the tremendous opposition from the ordinary rate-payers when he introduced steam-rolling. That was the case when I tried to purchase a steam-roller. One Councillor at a meeting of the County Council stated that if a steam-roller was sent into his district every man would rise, and it would require an army to overcome them. The steam-roller was sent, we overcame the opposition, and if I did not send a steam-roller into that district now I should hear about it at the next meeting of the Council. As to the cost of steam-rolling I find that in County Armagh, where we allow 1*l.* a day for the maintenance of the steam-roller, and wages of driver and firemen, with the employment of foreman and seven men for sweeping, spreading the stone, etc., the cost is about 1*s.* per yard. Occasionally we can do it at 9*d.*, but that is an exceptional case. For some years I had a mechanic to do the repairs, but I found that the roller always wanted repair. At last I got rid of the man, and the rollers now require very little repair. In my opinion the purchase of stone breakers is not a desirable thing if you have to move them about from quarry to quarry. Therefore I prefer to hire a breaker from the men who go round in the autumn with threshing-machines, and in the spring with stone-breakers.

Mr. J. CARTWRIGHT: I do not quite understand what Mr. Dorman's tirade is against; is it against contracting versus administration work?

Mr. DORMAN: The present contract system throws the whole work of road repair directly upon the farmer. The roads are farmed out for a period of years, and the responsibility rests upon the contractor.

Mr. CARTWRIGHT: Does not the county surveyor let out the work?

Mr. DORMAN: In sections. We take contracts for the material only. We own our own steam-rollers.

The PRESIDENT: It is a system which is difficult for us to understand. Letting out a road to contractors is a thing unknown in England.

A MEMBER: What is the shilling per yard for? It seems a high price.

Mr. DORMAN: The shilling covers the 1*l.* a day for the roller, two sweepers, two men for spreading the stone and levelling it on the surface, and three men for wheeling the stone from the side of the road, and horse and water-cart. We only pay 2*s.* a day to the men and 4*s.* a day to the foreman. The total cost is 43*s.* per day, and you would not roll in more than 43 yards of the broken stone in a day.

Mr. H. A. CUTLER: I think it would be interesting to know what it cost before the rolling was introduced, so that one could make a comparison. It is the cost of rolling, and not the cost of making the road.

Mr. DORMAN: You mean what it would cost to consolidate the stone. That is a question I could hardly answer.

Mr. CUTLER: It is only recently you have started rolling the roads.

Mr. J. MUNCE: I quite agree with Mr. Dorman as to the fraud practised by road contractors some years ago. When a lad I was sent out to measure some stones on a road not many miles from where we are. I measured them very accurately, and as a consequence the contractor was very angry with me. The curious thing was, after they were supposed to be spread on the road, they were found carted to another point on the road, and then piled up for remeasurement. The whole Grand Jury system of maintaining roads was an incentive to fraud, and it was not altered a moment too soon. They did not pay salaries to the district surveyors sufficient to enable them to keep honest; in some cases they did not pay sufficient for the car hire expended in visiting the roads to see the work done properly. Every one is glad that Mr. Dorman has got the direct labour system in his county. I think, however, he would find it cheaper in the long run if he hired his rollers. He has given us one instance of the expense in having a mechanic, who was always making work of repairs to the rollers. With regard to Mr. Cutler's paper, I think it is more a paper for quiet study than for discussion. Mr. Cutler has recorded some most interesting observations with reference to rainfall. The most curious thing observed in Belfast in years gone by is this—an amount of rainfall recorded in one day of twenty-four hours did not cause any flood at all, yet on another

day the same, or a smaller rainfall, caused a flood. It is the duration and rate at which the rain falls, and not the quantity, which requires most consideration. If the gullies and sewers are not able to take in a given time the maximum quantity falling during that period, there is more or less flooding. Mr. Cutler's paper will be a work of reference to those who have to design and carry out sewerage works.

Mr. J. P. BURKITT: In Fermanagh day labourers are exceedingly scarce, and therefore with direct labour the cost would be excessive except on a few main roads. I am also afraid my County Council would be shy of supplying sufficient staff to supervise a big scheme of direct labour without very convincing proof of its economy. Our contractors are farmers, and the workmen are mainly the members of their families. In spite of the absence of labour there is strong competition, which is shown by prices for roads coming down, though the work specified to be done is going up every year. Some of these farmers keep excellent roads. In our county the possibility of scheming by removing stones from one place to another cannot occur, as the custom has been to measure the stone when spread; and this is not at all so difficult or inaccurate, as it sounds and works very well. We have three-eighths of a year's supply spread in November, three-eighths in March, the balance put in in small repairs as required. We have done a little steam-rolling during the last two or three years, and hope to have more. Owing to the scarcity of labour I could not have introduced steam-rolling unless I had stone-breakers also. Nearly all the rolled stone is machine broken, and the breaker has been very satisfactory and popular. Contractors pay for its use, but they get the roller free of charge. We have a lot of bog roads which often entail roundabout ways of getting the machinery to a district, but though the engine has sometimes sunk a little, the breaker has not done so yet owing to specially broad wheels which we got made.

Mr. T. J. GUILBERT: I should like to propose a hearty vote of thanks to the authors of the papers, which have been full of interest. The paper on road maintenance was so different to anything of which I had experience as to the supply of material, that I did not at first understand it. Our practice is to issue contracts every three years for the supply of stone, including cartage, at per load delivered on the road as required. There

cannot be any corruption in that system because the foreman is on the spot, and the record of loads is taken as delivered, and given daily to the chief inspector. The system works out very well. In districts where weigh-bridges are available the stone is, however, passed over the bridge, and purchased at per ton, but in the rural districts, where there are no weigh-bridges, the first-mentioned method at per load obtains. The loads are of 31 cubic feet, the carts being measured and stamped before they are allowed to be used for delivery.

Mr. H. G. Nicholson Lailey: I have pleasure in seconding the vote of thanks to the authors of the papers. With regard to road construction and maintenance—What is the practice adopted in Ireland towards Rural District Councils? Do the County Councils contract with the Urban District Councils, or do they do the work themselves? In my county we have every year to make an estimate showing exactly what we are going to spend on our urban area, and we are paid so much a quarter by the County Council.

Mr. A. E. Adams: As to the scraper, I would like to know what is the lowest pressure the scraper can be used under. It occurs to me that in some districts I have to look after, with some of the low pressures, it would be difficult to get a scraper so successfully through the mains; and having to cut out and put in short pieces of pipe is a very expensive thing.

The vote of thanks was accorded with acclamation.

The President: I am sure the meeting is very much indebted to the authors for the excellent papers they have prepared. I can assure you it would be of very great advantage to the Irish engineers themselves if these meetings were held more frequently. In England we find the advantage to be very great indeed. We are able to see each other's methods of doing work; we are able to see experiments which are being made in various directions by other engineers, and we get a good deal of information on every subject with which an engineer has to deal. It is impossible for an engineer in a large town to be conducting experiments in every branch of the work he has to do. I heartily agree with the vote of thanks to the authors of the three papers. I wish there was time to discuss the papers more fully, but I am sure they will be studied by the members, and will be very valuable to everybody engaged in municipal engineering.

Mr. H. A. Cutler, in reply, said: When I wrote this paper I had not very much time to devote to the subject, but thought, in referring to various types of pumps, the members would have an opportunity of stating their experience with regard to the suitability of centrifugal or reciprocating pumps under various conditions. There is one statement in the paper which requires a little explanation. I refer to the statement that "practically the delivery of a centrifugal pump cannot be varied by change of speed, but it can be indefinitely varied from no delivery to about 60 per cent. above its normal capacity by varying the head, but not without loss of efficiency." My reason for the statement is that in practice one does not often see the discharge of a centrifugal pump varied by change of speed, and for a very good reason. If you diminish the speed by 15 per cent. below the normal the flow ceases altogether. If you diminish it by 5 per cent. you can diminish the flow by 25 per cent. It means that a small percentage of change of speed creates an enormous percentage of change of delivery; and we know that generally to get an engine to govern within 5 per cent. is a very good performance, so that the conditions are too critical to rely upon it in practice. I have a diagram here which shows characteristic curves for Worthington centrifugal pumps. The curves are for constant speeds, and they give percentages of the normal capacity for varying heads with the corresponding percentages of efficiency and brake horse-power. It is a very useful diagram, and it shows in a very clear manner what an efficient machine the centrifugal pump can be made if properly designed.

Mr. J. Cartwright: To what limits would you say a centrifugal pump is applicable?

Mr. Cutler: Practically any limit. A single fan centrifugal pump will lift considerably over 100 feet, and if you want to increase the lifting power you can have two fans or three fans in series.

Mr. Leebody, in reply, said: I have to thank you for the complimentary remarks you have made about the paper which I put together. Mr. Dorman referred to the figures as to the total possible expenditure and the actual expenditure on the roads. The total possible expenditure on the roads stated in the paper is the sum of the "limits" fixed by the Local Government Board, and the total expenditure is the sum of the

returns I obtain from the county surveyors. You will see we are, in the majority of cases, running very close to the "limits." It is the tendency to spend every penny.

MR. DORMAN: Some have gone over the limits.

MR. LEEBODY: There is trouble when that happens! The habit of shifting material from one road to another was very common in former days, but the practice of steam-rolling has practically put a stop to that, because it would be an ingenious man who would gather together the stone that had been steam-rolled on a road. This is a benefit from steam-rolling which would not occur to the ordinary outsider. Mr. Dorman also refers to the power in the hands of the district councils. Unfortunately, this is very great, and the whole tendency of modern legislation is to make it greater. Of course, ultimately this will work out a remedy for itself. Then as regards the maintenance of rolling plant, I never myself contemplated employing a mechanic. I think it is almost self-evident what would happen, especially if you employed an Irishman for the job; he would never be out of work. I have a considerable amount of machinery now, and every year I have it overhauled, getting a man from the makers to carry out what repairs are necessary. That works out satisfactorily and is economical, as the makers have a reputation to maintain. The increased price of rolling works out at from 1*s.* to 1*s.* 3*d.* per. cube yard of material over the old prices. The maintenance price is the same now as three years ago, but there is a reduction in the quantity of material to correspond with the increase of 1*s.* to 1*s.* 3*d.* per cube yard for steam-rolling.

The PRESIDENT: If the Irish members ever require information on points of practice, of costs and things of that kind, their English brethren will be very pleased to give it. I hope the County Surveyors and the Municipal Engineers of Ireland will encourage the young men of the profession to belong to an Association whose work is devoted to the public good, and encourage them to study so that they may pass their examinations and be competent to join the association.

MR. R. H. DORMAN: I wish to thank the members for the kind vote of thanks accorded to me for my paper.

MR. SWINEY: I wish to thank the members for the very kind expression of opinion they have given on the water supply scheme. The first question asked was as to the distance

between the hatchboxes. Some one thought they were rather far apart. One of the chief things that regulated the distance in this particular scheme is that hatchboxes are rather expensive. In fixing the distances I was also guided by the fact that we have plenty of pressure in the main. Therefore there is less difficulty in getting a scraper through the pipes. With regard to the pressure necessary to drive a scraper through a main if you have 20 feet to 30 feet of pressure behind a scraper in a main of 6 inches diameter you may expect to get it through with some little difficulty.

On Friday, May 17, *the first visit was made to the main drainage outfall works, the pumping station and purification works on the bacteria principle. Visits of inspection were also made to the Greencastle pumping station and the central fire station, where two surprise fire alarms were given, and responded to in* 13 *and* 10 *seconds respectively. Mr. Cutler entertained the Members to luncheon at the old castle. In the afternoon a visit was paid to Lisburn to inspect the sewage works which are in course of construction. The Members were met by Mr. Midgley Taylor who showed the party over the works.*

On Saturday, May 18, *after the discussion on the papers, the Members drove to the Toffany Storage Reservoir which was in course of construction, and were entertained to light refreshments by Mr. R. H. Dorman.*

NORTH WALES DISTRICT MEETING.

May 31 and June 1, 1907.

Held at the Council Offices, Colwyn Bay.

J. Patten Barber, M.Inst. C.E., President, *in the chair.*

The Chairman of the District Council, J. Williams, Esq., J.P., received the members, and offered them a hearty welcome to Colwyn Bay.

The President thanked the Chairman and the Council for the very cordial welcome given to the Association.

Mr. W. Jones was unanimously re-elected Honorary Secretary for the North Wales District.

COLWYN BAY AND A DESCRIPTION OF ITS PUBLIC WORKS AND FORESHORE IMPROVEMENTS.

By WILLIAM JONES, Assoc.M.Inst.C.E., Engineer and Surveyor to the Urban District Council.

In presenting this Paper to the Meeting, the Author cannot claim any great historical and archæological associations for his district, although the country immediately around is full of interest in these respects. The existence of Colwyn Bay dates back but a short time, and is due to the enterprise of a land and building syndicate known as the Colwyn Bay and Pwll-y-Crochan Estate Company, who developed the place with phenomenal rapidity. Twenty years ago it comprised only

very few dwelling-houses and cottages, and although the district can only now be classed amongst the smaller towns of the country, still it has been the Author's endeavour to make the Meeting as interesting as others which have been held in larger towns, and with the remarkable enterprise that has occurred, both on public and private lines, he hopes that it will prove so to the Members of the Association.

The district is classed as the most favourable seaside and health resort on the North Wales coast, and, with the abnormal growth that has taken place in such a short time, one can readily see that public works of an infinite variety must keep pace with its growing and increasing requirements, so that, for the last seventeen years, the Author's experience has been a very busy and arduous one.

Colwyn Bay is situated on the main line from Euston to Holyhead of the London and North-Western Railway at a distance of 219 miles from London, 57 miles from Liverpool, 74 miles from Manchester, 114 miles from Birmingham, and 50 miles from Holyhead. It is therefore readily accessible from all parts of England and Ireland. Its latitude is 53° 17′ N., and longitude 3° 5′ W., and its sea-border on the north-easterly side is cooled by the breezes of the Irish Sea. On the south-westerly side it is flanked by high, wooded country (rising to a height of 500 to 600 feet within less than a mile of the coast), which ranges around three sides of the town, forming a cosy natural crescent to shelter the same.

Apart from the local shelter thus obtained from the cold winds, the important point in the geographical position of Colwyn Bay lies in the presence of the high mountains of the Cambrian Range, some 10 to 15 miles to the south, south-west, and south-east. Over these the warm, moist breezes which have passed across the Atlantic in contact with the Gulf Stream, blow, dropping much of their moisture as rain, and giving out at the same time their latent heat, passing on cooler and dryer. The prevailing winds being from the south and west, the effect of this on the climate of the district must be very great and beneficial, and it is becoming more acknowledged each year that Colwyn Bay provides the mildest winter climate on the Welsh coast, easily accessible, a matter of much moment to invalids to whom travelling is a burden and a danger.

There is no staple trade or industry in the district, unless the building trade can be so described, as, naturally, owing to the large number of houses being built, a large number of men are employed. The population is largely residential, a number of residents being engaged in business in Liverpool, Manchester, Birmingham, and the neighbouring manufacturing towns of England. During the season the floating population reaches between 15,000 and 20,000.

As an educational centre, Colwyn Bay takes a very important place, possessing a large number of high-class schools and colleges.

Climate and Geological Character of the District.

The climate of Colwyn Bay as a whole is an equable one, being warmer in winter than Bournemouth and nearly as warm as Torquay, and cooler than those places in summer. The rainfall and the number of rainy days are moderate, the amount of sunshine large, and the number of sunless days are exceptionally small. The prevailing winds, as mentioned before, are from the south and west.

The following table, which was compiled by Dr. R. E. Lord, of this town, gives the climatological results for Colwyn Bay:—

General Climatological Results for Colwyn Bay.

	Mean maximum temperature 18 years.	Mean minimum temperature (16 years).	Mean daily temperature.	Mean daily range.	Rainfall (inches), 17 years.	Rainy days (0·10 and more).	Hours of sunshine, 1894–1896 (3 years).	Sunless days.	Humidity per cent (3 years, 1894, 1895, and 1896).
1st quarter ..	46·2	36·0	41·1	10·2	6·29	42·8	306·2	14·0	80·3
2nd " ..	59·3	44·1	51·7	15·2	6·05	37·2	686·5	3·3	72·9
3rd " ..	64·9	50·7	57·8	14·2	8·94	45·1	512·3	6·0	75·6
4th " ..	50·1	39·6	44·9	10·5	10·88	53·6	205·3	19·2	80·6
Year	55·1	42·6	48·9	12·5	31·66	178·7	1710·4	42·5	77·3

The Author might here state that his Council have provided a full set of meteorological instruments, which are under his charge, and the results are sent daily to the Press. The

geological character of the district consists of loose sandy soil, more or less mixed with interposed patches of clay and gravel. The different parts of the town vary irregularly in the formation of the ground, but it may be stated generally that at the western end there is more clay, while at the eastern end gravel and sand predominate. The glacial geology of the district is particularly interesting. The surrounding hills differ considerably in their formation, as on the extreme east side and on the west side the rock consists of carboniferous limestone, while on the southerly side they are of Wenlock shale. Very few trees are, as a rule, found on the former hills on account of the thin surface of the soil and rapid percolation of the rain through the limestone; whilst the hills and slopes of the shale are abundantly covered with trees, for the rain, being unable to penetrate its substance, remains to a great extent in the surface soil, often producing peaty collections. The great majority of houses are built on the gravel or sand. The district abounds in rich and varied flora.

General and Vital Statistics.

The area of the district is 5541 acres, and it was constituted an Urban Authority in 1887 with twelve members, receiving the more dignified title of Urban District Council in 1894 by virtue of the powers conferred under the Local Government Act. In 1905, owing to the rapid increase of the population, the district was divided into four wards, and the number of members increased from twelve to twenty by order of the County Council. The Author is pleased to record the fact that all the members are animated with the desire to make the town popular and attractive.

The following table shows the growth of the district during the last seventeen years:—

Year.	Inhabited houses.	Population.	Nett rateable value.
			£
1891	833	4,754	24,751
1901	1605	8,689	52,837
1907	2311	12,000	79,767

The gross rateable value for this year is £99,748.

As already mentioned, the estimated visiting population during the season is upwards of 15,000.

Most of the building operations are carried out during the winter months, and since April, 1901, 706 new houses have been erected in the district, viz.:—

1901, 133; 1902, 163; 1903, 75; 1904, 103; 1905, 105; 1906, 127.

To further demonstrate the wonderful enterprise of the public authority in order to increase the attractions of Colwyn Bay, it should be here stated that the outstanding loans of the Council amount to £254,837, which proves that they have spared no pains to maintain its reputation. From the last report of Dr. P. Fraser, the Medical Officer of Health, it will be seen that the district enjoys a most remarkably healthy state. The death-rate (including the visiting population) from all causes was 11·6, but the corrected death-rate for the resident population only equals 9·1 per 1000. This, it will be admitted, is amongst the lowest rates for any town in the United Kingdom. The birth-rate is 19·0 per 1000, and the zymotic mortality only amounted to 0·36, as compared with a rate of 1·52 for England and Wales.

WATER SUPPLY.

The water supply of Colwyn Bay and Colwyn is obtained from Lake Cowlyd. The lake and the trunk mains which bring down the supply are owned and controlled by the Conway and Colwyn Bay Joint Water Board.

It is not intended here to give a detailed description of the Joint Board's Water Works, as their Engineer (Mr. Farrington) will do this in the paper he has been good enough to prepare for this Meeting.

The distribution of the supply within the district of the Colwyn Bay Urban Council is entirely under the control and supervision of the Author, and during his term of office he has laid and extended over 18 miles of water mains in the town, varing in sizes from 3″ to 4″ in diameter.

The most important improvement recently carried out in connection with the Water Works has been the provision of a supply to the higher parts of the district.

These High-Level Water Supply Works were formally

opened on October 12 last, by the ex-Chairman, Mr. J. Herbert Roberts, M.P.; and a short description of them may be of interest.

The new Works comprise a pumping station and pump well, which have been built in the Pwllycrochan Woods, now the property of the town, the position of which is at an altitude of 300′ above Ordnance datum, this being the height to which the average night pressure by the Joint Water Board's supply in this district now attains.

The pump well is on the outside at the back of the pumping station, and has been excavated in the solid rock. It is constructed of best Portland cement concrete (5 to 1), the walls being of an average thickness of 2′ 9″. The floor is 2′ thick. The well is covered, and its depth is 24′. It has a capacity of 25,000 gallons, or one-tenth the capacity of the service reservoir.

The supply received from the Joint Board gravitates to the well, which can be filled each night; but the present demand on the new Works does not occasion more than the filling of the well once a week, the consumption now representing only 25,000 to 30,000 gallons per week.

The pumping station has been designed of a character that will detract as little as possible from its sylvan surroundings. The material used has been Pantygloch stone in random rubble, pointed, with limestone ashlar for plinths, quoins, door and window openings, and for the castellated coping.

Only one set of machinery is at present installed in the station, but the building has been made sufficiently large to receive duplicate plant when necessity arises.

Solid foundations of concrete have been built in the station for both the engine and the pump.

The pump is a horizontal treble ram, and is capable of lifting 5000 gallons per hour to a height of 400′ through the 6″ rising main. It is fitted with raw-hide pinion and other improved gearing to reduce the noise, when running, to a minimum. It is driven by a gas-engine of the ordinary type, capable of developing a working load of 16 B.H.P. The fly-wheel is 5′ in diameter, and the engine is fitted with all the latest improvements.

A service reservoir of 6 to 1 best Portland cement concrete has been constructed on land acquired from Mr. J. Brock, J.P., Gwern Tyno, the area of which is two acres, allowing ample

room for future extensions, the price paid for the land being 240*l*. This land is at the highest elevation of the Gwern Tyno property, and the top water-level of the reservoir is 650′ above O.D., so that the pumps have a lift of 350′.

The thickness of the walls at the base is 3′ 9″ battering to 2′ at the top; the floor is 1′ 6″ thick; and the reservoir is uncovered; the depth of water being 12′.

From the reservoir, distributing mains of 4″ and 3″ diameter have been laid for the supply of the various premises within the area of supply, the former main being 2300 lineal yards and the latter 1650 lineal yards in length. The length of the 6″ rising main between the pumping station and the reservoir is 1500 lineal yards, and is sufficient for the delivery of 8500 gallons at a velocity of 2′ per second, so that when the duplicate plant is required, there will be no necessity for the laying of an additional rising main.

It will be observed that over three miles of mains have been laid in this scheme, and a sufficient number of suitable sluice air, and reflux valves, also hydrants and fire plugs, have been provided on the same, the whole of which are distinctly indicated by plates fixed above ground.

The scheme was prepared by the Author, and the whole of the works were carried out under his supervision. The work has been most satisfactorily executed and completed, and the makers of the machinery have given the utmost satisfaction in the quality and efficiency of their part of the contract.

The Engineer's estimate for carrying out the whole of the works was 4377*l*., and it is gratifying to him and to his Council that the scheme has been finally completed well under the estimated cost.

The continued growth of the district calls for further development in its public water supply, and in this direction the Author has recently submitted to the Council reports and preliminary estimates for the constructing of a large covered balancing service reservoir, with a capacity of 5,000,000 gallons; but for the present no final decision has been arrived at by the Council.

Sewerage.

After the question of a pure water supply, the next most desirable object to be secured in every health resort is a perfect

and satisfactory system of sewers; and this, it is gratifying to learn, has now been attained in this district.

It is not intended under this head to give any details of the New Intercepting Sewer and Outfall Works now about to be completed under the supervision of Mr. Robert Green, M.I.C.E., of Birmingham, as he has been good enough, upon request, to submit a paper to this Meeting, fully describing these Works.

The first system of sewerage for the district was undertaken in 1877, during the days of the Rural Authority, the same being designed and carried out under the late Mr. James Farrar, C.E., of Bury, Lancashire. Three schemes were laid, one for Colwyn Bay, another for Colwyn, and one for Rhos, each having a distinct and separate outfall discharging into the Bay, as in those days it was much easier to satisfy the Government authorities as to sea outfalls than it is at the present time; for neither of the three would now satisfy the conditions necessary and required before the Government would sanction sea outlet for sewage.

However, with the inauguration of the New Outfall Works, the existing three outfalls will be converted into storm outlets or overflows, which will be a great improvement.

The whole of the town sewers consist of stoneware and earthenware socketed pipes, varying in diameter from 9″ to 24″, and are laid in straight lines from man-hole to man-hole. The extent of the sewers has been more than doubled during the Author's period of office, the present total length being over 25 miles.

They are nearly all laid with self-cleansing gradients, the joints being luted with Portland cement compo, and all new sewers are water-tested before being covered up.

Up to the introduction of the New Works, the system had been a combined one, but (as will be explained by Mr. Green, in his Paper) for the future the separate system will have to be adopted, and with this object in view extensive lengths of surface-water sewers have already been laid and are now working.

Except in few instances, the ventilation of the sewers was originally obtained by means of surface gratings; but with the advancement of modern opinion in this respect, shafts are being erected at suitable and convenient positions, with very good results.

Highways, Footways, etc.

The total length of roads repairable by the Council is about 48 miles. Four and a half miles of these are "main" roads, towards which the Denbighshire County Council contribute about three-quarters of the total cost of maintaining the same. There are, in addition, about $8\frac{1}{2}$ miles of "unadopted" or private streets. The Author has practically widened the whole of the main road during his period of office.

The total expenditure last year was as follows:—Highways, 1931*l.*; main roads, 807*l.*; but the previous year over 1000*l.* was expended on the latter.

The surfaces of all the carriage-ways are macadamised, Penmaenmawr granite being used on the main roads, and on the highways in the residential parts of the district over which the bulk of the traffic passes. On the secondary roads, which are subject to lighter traffic, limestone from the local quarries is used; but the Author strongly deprecates the use of this material on roads which are subject to constant traffic, as it is rapidly ground up, and has to be picked up as mud in wet, and as dust in fine, weather, and he has no hesitation in stating that the use of granite macadam is a greater economy in the end. The price paid for granite is 5*s.* 6*d.* per ton delivered at the railway station, and for limestone 3*s.* per load at the quarry. The Council possess a 10-ton steam roller, and a scarifier which is drawn by the roller. This works well, and does not subject the roller to the same strain as those which are attached. The cost of the scarifier was 65*l.*

Owing to the development of the district, constant and repeated breaking up of the roads takes place for gas, electricity, water, and drains, so that it can hardly be expected that the surface can be maintained in the satisfactory condition one could desire.

Motor-car traffic in and through the district is greatly on the increase, and as many as 187 cars passed along the main road on August Bank Holiday last, and with this innovation is the accompanying dust nuisance, of which strong complaints are made by the public generally, and especially by the shopkeepers. The Author, like numerous others of his fellow-Members, has been called upon to adopt some measures to abate

this nuisance, but so far his endeavours have only extended to an experimental stage, and this has consisted of coating the road surface with a patent compound called "dustoid," which he understands is a mixture of tar and common salt, and is made locally, the price paid for the same being 48*s.* per ton. A length equalling about 3300 superficial yards of the main road was taken in hand last July. The surface was thoroughly swept, and all dust was picked up; the composition was heated in boilers, and poured from buckets over the surface, and well brushed in, and immediately sprinkled over with fine chippings to dry up the surface for the vehicular traffic, which was allowed to straightway pass over it. Both limestone and granite chippings were tried, and the Author's preference is undoubtedly for the latter. The residents and shop-keepers along this length admitted freely that the process had greatly improved matters, and from official observations made it was found to answer the purpose required, and it proved a temporary remedy for the dust nuisance.

It is the Author's opinion that if all macadamised carriage-ways were treated in this manner, it would prove a saving in the cost of scavenging and watering, and would somewhat preserve the surface and tend to deaden the noise of the traffic, without taking into account the absence of dust in dry weather and mud in wet weather.

The cost worked out at 1½*d.* per superficial yard, but if the work was undertaken to a greater extent, it could be done at, if not slightly under, a penny per yard, which would mean 50*l.* per mile of the main road of this district.

The most opportune time to take this work in hand would be in May or June, and further experiments are now being undertaken with this material.

An experiment has also been carried out on the Promenade carriage-way opposite the Railway Station, with a composition consisting chiefly of pitch in a rather stiffer condition than is generally used, and this has proved a remarkable success, for although laid down nearly 12 months ago, the surface is almost as good now as it was at the time it was done, and appears to be quite equal to tar macadam, although the Author cannot say it has been subjected to a very heavy traffic. Similar procedure was adopted with this material, but owing to the extra labour required to lay it down and to the slower

rate at which the work can be carried out, the cost worked out at 2½*d.* per superficial yard.

The Author has received instructions to further experiment with palliatives, and he will be pleased to communicate his experience to any Member of the Association, and he will also be glad if the short reference that he has made to this matter of dust-laying will induce a free discussion amongst the Members, in respect to this most vexed question of the present time. Members are invited to inspect the trials that the Author has recently carried out.

In concluding these remarks, the Author cannot help but express his feeling that the only remedy for the dust complaints (in his opinion) is the adoption of tar macadam for all macadamised carriage-ways.

Most of the footways are laid with tar pavements, the earlier work of this description being carried out by contract, but for the last seven years the Council have undertaken it themselves by direct labour. Greater satisfaction has been received from the latter course, and better work is accomplished; it has besides proved a great saving in cost, for the contract price for the work ranged between 1*s.* 4½*d.* to 1*s.* 7*d.* per superficial yard, as against 1*s.* 2*d.* to 1*s.* 3*d.* per superficial yard, the cost of the work now being done by the Council's own staff.

Some of this work was done under loan sanctioned by the Local Government Board, for which a period of 10 years was allowed for repayment, although the pavement rarely lasts this time without having the top layer renewed, that is, if it is subject to constant traffic; so that this form of footway paving is not now looked upon with the same favour that it was some 10 to 15 years ago; and upon steep gradients in some of the streets it becomes very slippery with the wear on the surface.

The following is a description of the manner in which the work is carried out by the Author—

The limestone and chippings are procured from local quarries, and have to be free from clay and dust. The tar used is thoroughly distilled, so as to expel all volatile matter and objectionable oils, and has sufficient asphaltum or pitch added to bring it to a stiff consistency. The materials are mixed under cover on a hard or boarded floor.

The first or bottom layer of the pavement is composed

of clean limestone macadam broken to 1″ mesh, sufficiently incorporated with the bituminous mixture, which is poured on hot, and the whole well turned over and mixed together. This layer, when rolled and thoroughly consolidated, is to have a thickness of 3″.

The top or finishing layer consists of clean limestone, sized through riddles $\frac{3}{8}''$ and $\frac{1}{2}''$ mesh, well dried, and thoroughly incorporated with the bituminous mixture, and is laid on the first layer, and, when rolled and thoroughly consolidated, it has a thickness of at least $1\frac{1}{2}''$. The pavement when thus completed forms one homogeneous mass $3\frac{1}{2}''$ thick, which at finish is gritted over with fine white spar or other suitable grit, the same being again rolled over to a fairly even surface. Considering the very reasonable cost of this pavement, the Author believes that it compares very favourably with work of similar nature.

Tree-Planting on Highways.

Another feature in connection with the highways which the Author has had in hand, is the planting of trees on the public and private streets within his area, and a few words on this head may not be out of place.

Owing to the rapid manner in which the erection of buildings has been going on, it has been the wish of the Council to plant trees in all streets where possible, so as to maintain the rural appearance desired for the place by both residents and visitors, and with this object they undertake the planting of trees, even in unadopted streets, conditional upon the abutting private owners providing the trees. It is to be regretted that more local authorities do not give this matter the attention it deserves, as it not only increases the attraction of a district, but it materially adds to the health of its inhabitants. The trees are planted about 15 yards apart, and the procedure adopted for planting them is as follows:—A hole, about $4\frac{1}{2}'$ wide, is dug in the footway, immediately next the kerb, to a depth of quite 3′, and the excavated material is removed, the hole being refilled with good virgin soil or fine loam, mixed with some prepared compost, to which is added a couple of barrowfuls of old manure, the whole being well trodden down. The tree is planted as soon as sufficient soil has been filled into the

hole, and, the roots being arranged, the remainder of the filling is done, and levelled up with the surface of the path. If the subsoil under the tree happens to be clay or impervious material, a layer of rubble or broken brick is placed at the bottom, to facilitate drainage. The young trees are all staked by a single pole, and a guard of wire netting, of a small mesh, is put round to protect the same. The Author finds that the lime and the sycamore are as suitable as any for planting in the streets of his district, and he has also planted the elm, ash, poplar, and beech, but the latter does not seem to thrive or to take to the ground so congenially as the others named. In one street the service tree had been planted, and, with its flower and berry, was much admired, but, with the introduction of tar-pavements, this, as well as some of the others, appear to be affected, and does not thrive as it did before this paving was laid. One street has been planted with variegated sycamore and copper beeches alternately, the former of which thrives, but the beech does not do well, and looks weak, still the contrast in foliage gives a pleasing appearance to the road. Wynnstay Road, which is in close proximity to the Council Offices, has been planted with limes, and all are growing and thriving most successfully. It would be well if the Members would look at these.

Public Lighting.

The lighting of the highways of the district is accomplished by gas and electricity, and it will be observed that this part of the public duty imposed on the Council is carried out very thoroughly. Great improvement followed the introduction of incandescent mantles and high power for most of the gas lamps. There are 27 high-power lamps and 293 ordinary lamps fixed in the streets of the district, and 76 electric arc lamps, 67 of these latter being along the promenades. The public lighting cost the Council last year 1217*l.* (692*l.* for gas and 525*l.* for electricity), but they are in the happy position that as both their gas and electric undertakings are paying concerns, they are greatly relieved by the assistance derived from the profits of these two concerns. The Author hopes that his Council will be able to extend and still further improve the public lighting of the district by dropping the out-of-date practice which still

prevails here as in most towns, of economising in the hours of lighting, and depending for assistance on "lunar phases," which, to the general inconvenience, turn out sometimes to be most unreliable, and that they will also soon decide to keep some of the lamps alight all night, which may be a benefit to some part of the community.

Private Street Works.

In connection with this part of the duties of a municipal officer, the Author has been called upon during his period of office to undertake and supervise a great deal of private street works, and, in fact, it would not be exaggeration were he to state that he has had the making up and reconstruction of quite 50 per cent. of all the present by-streets of the district. The Private Street Works Act, 1892, was adopted very soon after it was passed, and the Author readily admits that it has improved matters and greatly facilitated the carrying out of private street works, as compared to taking these proceedings under section 150 of the Public Health Act, 1875, and his experience has been very wide under both statutes.

Should any of the Members desire information as to the specification which is insisted on by the Council in the making up of private and other streets within their district, the Author will be pleased to supply it on application.

New Buildings and their Drainage.

The bye-laws now in force are the old model series of the Local Government Board, but these will soon be superseded by a new set, as a Committee of Revision has had the matter in hand for some time, and the new draft is now ready for submission to and approval by the Local Government Board.

All building plans are deposited with the Author, and are reported upon by him, in writing, to a New Buildings Committee, who meet once a month, this Committee being also the Sanitary Committee. The plans are provisionally approved or amended, and are recommended to the Council for final approval at their monthly meetings.

With reference to the thickness of walls of new buildings—by the particular section which refers to this, all new buildings

comprising more than two stories are required to have the external and party walls of a thickness of 14″ below the level of the floor of the topmost storey, and 9″ in thickness for the rest of its height. The Author has rigidly insisted on this, although much protest was made by speculative builders against this maximum thickness of walls, on the ground that it was unnecessary and expensive.

Prior to the Author's appointment, the joints of new drains and sewers were made with puddle clay, and when he introduced the system of cement jointing, inspection chambers, and intercepting traps, he met with considerable opposition from speculative builders; but he records with pleasure that he was fully supported by his Council in his attempt to bring about a high standard of sanitation, which he believes he has accomplished, and which is in itself a sufficient recompense to him for the friction which occurred at the time. All drains of new buildings are now hydraulically tested before being covered up, and, in order to encourage builders to apply the test, the Council grant the use of sewer and drain plugs for the purpose, free of charge.

House-Scavenging.

Nearly all the houses within the district are provided with portable iron bins, and the ashes and refuse removed weekly; but in the case of large boarding-houses and hotels it is removed twice and in some instances three times a week. The few remaining ashpits which still exist are cleared on an average once a month, and this work is now carried out with an exact periodical regularity that leaves little room for complaint.

Owing to the large extent of the collecting area, the Council were obliged to acquire and rent three sites for tipping on, viz. the eastern, central, and western, on the ground of economy, and in order that the accumulation should not increase into too large a bulk at one place, thereby causing a nuisance.

The question of a refuse destructor has several times been considered by the Council, but it has been relegated to the future. There is, however, no doubt that it must, within the next two or three years, come again before the Council for their very serious consideration, as the rents of the tips are high, the cartage to the tips is an excessive item, and it is widely

acknowledged that the disposal of house refuse and ashes into tips cannot be considered satisfactory from a sanitary point of view.

The number of loads of refuse removed to the tips during the last six years is as follows:—

1901	..	5822 loads.	1904	..	6812 loads.
1902	..	5963 „	1905	..	6587 „
1903	..	6336 „	1906	..	6996 „

The annual cost of this work for the last year was 1166*l.*, and to give the Members a more detailed statement of cost, the Author has prepared the following table:—

COST PER LOAD FOR THE REMOVAL AND DISPOSAL OF ASHES AND HOUSE REFUSE.

Position of tip.	Scavengers' wages (per load).	Cartage (per load).	Rent of tip (per load).	Total cost (per load).
	s. *d.*	*s.* *d.*	*d.*	*s.* *d.*
Eastern	1 0½	2 1½	6¾	3 8¾
Central	0 10½	1 8¾	5½	3 0¾
Western	0 11¾	1 8	3¾	2 11½

ISOLATION HOSPITAL.

Until quite recently accommodation for the isolation of cases of infectious disease did not exist except in a very crude character. In the year 1902, however, the Council became fully alive to the necessity of providing adequate sanitary defence for the protection of the district against the spread of these diseases, as all seaside and health resorts are peculiarly subject to the introduction of infectious diseases.

After experiencing much difficulty in securing a suitable site for an isolation hospital, the Council acquired two and a half acres of land on the Cayley Estate, situate about a mile and half from the town.

In 1903 the Author was called upon to prepare the necessary plans, etc., and although the site chosen presented some difficulty in its adaptation for the several buildings, owing to the very sharp fall in the ground and to the necessity of fully complying with the official suggestions and recommendations of the Local Government Board, the plans were in due course approved.

The institution at present consists of a pavilion of two wards with four beds in each, the wards being divided by a nurse's duty-room and a spacious hall. The conveniences are arranged as annexes at each end of the two wards and are ventilated by means of two louvre ventilators on either side of the external wall leading thereto.

As requirements demand, a similar block to this will be erected, the site and position having been arranged for at the outset.

The second building comprising the hospital is a small ward-block of two wards with two beds in each, which are separately entered from the open air under a verandah. The wards in this block are also divided by a nurse's duty-room in the centre, the position of which enables a proper supervision to be kept on the wards. A similar block to this will also be erected when necessary to meet increased demands, its position on the site having already been fixed and arranged, and when the whole of the hospital buildings are erected, they will form a quadrangle with the administrative block in the centre on the outer side. This block is already erected, and consists of the following accommodation :—Dining and sitting-room for matron and nurses, medical attendants' room, with surgery, kitchen, scullery, and the required outbuildings, several bedrooms with bathroom and water-closet. The out-offices or laundry block, which have also been erected, consist of a laundry-room, disinfecting chamber, with a steam disinfector, and separate rooms for infected and disinfected clothing or articles, also a mortuary room and ambulance shed.

The heating of the hospital wards is accomplished by means of patent slow combustion ventilating stoves. The stoves in the small block are single fire with direct vertical flues, and act admirably; but the stoves in the larger block are double fire, fixed in the centre of the wards with downward and horizontal flues to the side of the building, and the Author has experienced the greatest difficulty in getting these to work properly, especially when the wind is from an easterly direction. The Author would caution his fellow-members against the adoption of this latter kind of stove, unless the position of the building is a very open one.

The ventilation of the wards is accomplished by means of double-hung sash windows having fanlights above, made to

open inwards; also by openings made in the walls under each bed, and controlled by ventilating grids which can be opened and closed by means of a key. Stott's patent exhaust ventilating cowls are fixed on the ridges and connected by an opening from the centre of the ceilings of each ward, so that a thorough change of the air in each of the wards is secured.

With regard to the space allowed for the beds in each ward, strict observance has been given to the requirements of the Local Government Board, and each bed has 12 lineal feet of wall space, 144 square feet of floor space, and 2000 cubic feet of air space.

Public Buildings.

The District cannot pride itself on being possessed of any ornate public buildings, as sufficient time has not elapsed since the commencement of its growth to allow for the laying out of much money in this direction. The Council acquired the premises which they now occupy as offices in 1903, the purchase money being 4500*l.* Previously they were two private dwelling houses standing on an area of one acre of land. The Author was instructed to prepare plans, etc., for the conversion of the premises to suit the requirements of the various departments of the Council, and he spent about 1000*l.* in making the necessary alterations and the erection of an additional large room for use as council chamber.

The Libraries' Act was adopted in May, 1901, but it was not until 1904, through the beneficence of Mr. Andrew Carnegie, who contributed 3785*l.* towards the cost of a free library, that an outside committee of townsmen carried the whole of the negotiations through and completed the erection of the library, which was opened in April, 1905, and then handed by them to the Council. The total cost of the land, building, and furnishing was 5436*l.* The ratepayers' legal contribution of one penny per 1*l.* per annum, towards the up-keep of the library, amounts to 280*l.* this year. The library and news-room is greatly appreciated by both residents and visitors.

The County Authorities are now erecting premises in the district for police and magisterial purposes, at a cost of nearly 8000*l.*, and these, when completed, will be a very fine and convenient block of buildings.

PUBLIC CONVENIENCES.

The greatest difficuly has been experienced in securing suitable and convenient positions for the erection of sanitary conveniences for use by the public of either sex, and it is. only quite recently that it has been possible to make any progress in this direction, owing to the prejudice which was so strongly shown by property owners and residents adjoining the proposed site of these structures. It is now evident that the days of the old cast-iron urinal kiosk are done, it being unsuitable for its purpose, often a nuisance, and generally an obstruction on the highway. The public, therefore, expect improvements in this direction, and there is no doubt but that it has been accomplished by the Municipal Engineers in some of the larger towns, where underground structures of this description are well worthy of inspection, their internal finish presenting a most cleanly and pleasing appearance.

The Author has not had so free a hand in respect to the one he has recently erected above ground on the promenade, but he invites an inspection of the same by any of the members who have in hand the erection of similar structures. It comprises, in the gentleman's section, three closets and a range of four circular backed urinal stalls, and a separate lavatory-room having a range of three wash-basins; there is also an attendant's room, which can be used as a cloak room. In the ladies' section there are four w.c.'s, a separate lavatory-room having a range of three wash-basins, also a dressing-room, which can be used either as an attendant's room or cloak-room.

The building presents a pleasing appearance, being built of "Connah's Quay" facing bricks, panelled, and roofed with green slates and red ridge tiles. Internally, the walls are lined with glazed brick up to a height of 4 feet 6 inches, with moulded brick capping forming dado, finished above with pressed brick similar to the outside, and Terrazo has been chosen for the flooring. The whole of the woodwork is painted with white "Velure," and the glazing is 21 ounce "Muranese."

The building is lighted throughout with electricity.

The fittings are of white porcelain marbled in imitation of "St. Anne's" marble.

The w.c.'s have mahogany seats, and 3-gallon white porcelain fire clay syphon cisterns and brass flush pipes.

In this urinal the Ladies' and Gentlemen's compartments are under the one roof, the entrances being at each end of the building. The point has been considered whether separate buildings for both sexes would be preferable, but the existing arrangement has been found to work well in practice.

The cost of this urinal was as follows, exclusive of the value of the land:—

	£
Building	420
Fittings	102
Lighting	12
Tar Paving, Paths, &c.	5
	£539

The Author has also erected two urinals on the Council's property in the other parts of the town, viz.:—Adjoining the Electricity Works, and also at the rear of the Free Library. The former consists of a range of four urinal stalls, and the latter a water-closet and a range of four circular-backed urinal stalls. All the stalls are of white porcelain, and the urinals are open to the external air, there being no roof over the same. The cost amounted, in the former case, to 91*l.*, and in the latter to 99*l.*

It will be noticed that all these conveniences have been erected on land owned by the Council, and not upon land directly acquired for that purpose, owing to the prejudice previously referred to.

The Author is about to commence the erection of another above-ground public convenience on the Promenade, for which a tender amounting to 750*l.* has been accepted. It will be somewhat similar in appearance to that he has already described herein, but slightly altered as to the interior arrangements. A sanitary convenience is also about to be erected at the Council's Cemetery.

Parks and Pleasure Grounds.

The District does not possess any artificial ornamental Parks and Pleasure Grounds, as those terms are understood in most towns. These names locally mean in this District wooded hillside slopes, which have been acquired by the

Council for the public use. Foremost amongst these is the famous "Pwllycrochan" Woods, a literal translation of which word means a "pool into which a rushing and furious stream coming down the hillside discharges." These Woods, comprising 40 acres, were purchased from the Estate Company by the Council for 7500*l.*, and are open to the public all the year round. No artificial ornamentation has been necessary to beautify this natural Park. It forms a sloping back-ground on the south side of the town, rising gradually to a height of about 150 feet, and few, if any, seaside places can boast of such a sylvan paradise. The charm of this wooded hillside lies in the variety and abundance of its trees, and the wealth and colour of its ever-changing foliage—in the peacefulness of its great silence, and in the shelter which it accords from cold winds. A number of new gravelled footpaths and rustic bridges have recently been made, and are much appreciated, especially those that lead to the higher heights of the District above the Woods, and the scenery from here is one that will not easily be forgotten.

Another natural Park is situated on the eastern portion of the District, and was secured by the Council for the public use, by a deed of gift from the Trustees of the Cefn Estate, and comprises an area of 2 acres and 31 perches. These grounds are charmingly picturesque, sloped on both sides of a beautiful, clear-running, winding stream.

The total cost of laying out and making the paths did not exceed 80*l.*

Cemetery.

Great difficulty has been experienced by the Council in procuring a suitable site, but fortunately they induced the Cayley Estate to sell a field at Bron-y-Nant, comprising 5¼ acres, for 1197*l.*, and this area is estimated to meet the requirements of a population of about 21,000 until the end of the repayment of the loan in 46 years. The strata is most suitable, being of a gravelly nature throughout, and is such that both air and moisture will penetrate to assist decomposition. There is no need of under-drainage, and the only drains laid are those necessary for taking away surface water from the gravelled paths.

The Author has designed the internal roads in such a way as to be sufficiently wide to allow of vehicles passing one another, and extended them through the sites so that every part can be reached.

The boundary walls on the East and South sides are built of limestone rubble, the boundary on the North and South being of unclimbable iron railings. A space of 15 feet is reserved on the inner side of the boundaries for shrubs and evergreens, so as to give the place as pleasing an effect as possible.

The number of graves available on this land is 4200, and the Council have recently alloted a section of the site for the use of the Roman Catholic Denomination.

It is not for the present intended to erect either Chapels or Lodges, and the only erection at present put up is a tool and greenhouse, but the author has been directed to erect a sanitary convenience with two urinal stalls and two water-closets. A sum of 1771*l.* has been expended in the purchase of the site, and in the laying out of the land, and the making of the roads and footpaths; the whole was completed satisfactorily in the year 1904, when the first interment took place.

Fire Brigade.

The district is provided with an efficient Fire Brigade under the control of the Council, and managed by a committee consisting of six members of the Council, and six outside gentlemen. The equipment consists of a steamer capable of pumping 250 gallons of water per minute. This was purchased in 1893, and was the first steamer procured for a town Brigade in North Wales. They are also provided with a curricle fire-escape, hose-car, and all modern appliances necessary for an up-to-date Brigade. The Fire Station adjoins the Electricity Works, and is situated in the centre of the town. Over the Station a Recreation Room for the Firemen has been provided, having a billiard table for their leisure.

Electric bells have been laid from the Fire Station to each fireman's house, and this has proved a great improvement over the old fire alarm bell, which stirred not only the firemen but the whole of the town upon each alarm, to the great hindrance of the firemen in the discharge of their duties.

Gas and Electricity Works.

The Gas Works were in the hands of a private Company until the Council acquired the same by Act of Parliament promoted in 1901, in accordance with a clause inserted in the Gas Company's Act of 1896, whereby they consented to the sale of the undertaking to the Council within a period of five years from the passing of their Act. The sale price being fixed by arbitration, the total amount of the Loan raised by the Council in order to acquire the same and pay all costs incurred was 74,260*l.* and it is gratifying that even in the face of this large expenditure the undertaking is a profit-earning concern.

The price of gas for lighting and cooking is 3*s.* 4*d.* per 1000 cubic feet.

The Electricity Works are also the property of the Council, and are a profit-earning concern, and were first inaugurated under the Author's charge, who also supervised the erection of the buildings, but a description of the works will be given in Mr. Tudman's paper.

New Promenade and Foreshore Improvements.

The Author's experience under this head has been a very wide and extensive one, as he has been directly responsible for an expenditure on public works of this character to the extent of over 60,000*l.*

In 1890, the first year of his office, he was commissioned to carry out and construct approach roads and suitable access to the Beach. These were completed in 1891, and now form the principal approach to the Promenades and to the Victoria Pier and Pavilion, the cost being 8000*l.*

In 1895 he was directed to prepare plans, etc., for a Promenade nearly a mile long on a part of the Beach acquired from the Crown, and this extended from the Colwyn Bay Railway Station for a distance of 1423 yards.

This work was carried out by contract under the entire supervision of the Author. It was commenced in the early part of 1896, and completed towards the end of 1897. The total cost of this work was 15,000*l.*

This improvement proved a great benefit and attraction to both the residents and the visiting public; in fact, to an extent,

that greatly tended to the growth and progress of the District, which induced the Council to take into consideration the advisability of extending these Foreshore improvements. In 1901 the Author was further instructed to prepare plans, etc., for the construction of New Promenades in both directions along the sea front, as it was thought that these improvements would not only prove of further attraction to the District, but they would also form a protection for the New Intercepting Sewer which the Council had now decided to construct along the Foreshore in order to meet the growth of the District.

The Author, therefore, produced his plans and estimates, etc., for three sections of New Promenades, in order to complete the continuity of these improvements along the sea front.

The first section extended from Rhos-on-Sea along the front of the Cayley Estate for a distance of 940 lineal yards, the owners of this Estate making a contribution of 15,000*l.* towards the cost, the estimate of which, with the cost of land, was 24,835*l.*

Section No. 2 extended from the Colwyn Bay Hotel to the Railway Station, a distance of 285 lineal yards, the estimated cost being 9098*l.*

Section No. 3 is at the East end in Old Colwyn, a length of 800 lineal yards, the estimated cost being 9091*l.*

These sections were approved by the Council, and an application made to the Local Government Board for sanction to raise the money to carry out the same, but owing to the cost of these, and the cost of the New Intercepting Sewer and the Sewage Disposal Works, which the Council had now taken in hand, together with the outstanding Loans, exceeding their statutory borrowing powers, the application to the Local Government Board was dropped, and a Bill was promoted in Parliament for the carrying out of these Promenade Works and the Sewerage and Sewage Outfall Works, at a total cost of 112,000*l.*, which received the Royal Assent on 31st July, 1902.

These works and improvements are now practically completed, and the Author will briefly describe the portion over which he acted as the Engineer; and Mr. R. Green, M.Inst.C.E., of Birmingham, has, at the Author's request, kindly undertaken to give a full description of the Sewerage Works, over which he acted as the Engineer.

The Promenade Works comprised the erection of a strong sea-wall, built on a cement concrete footing, the outer side of the wall being built of limestone masonry in fairly large blocks, with Portland cement mortar, and having a batter on that side of 1 in 4. The whole of the stone had horizontal beds and vertical joints, with rock face, and were pointed with cement compo. as it was being built up. On the inner side the sea-wall is backed up with 6 to 1 cement concrete to its full thickness, and has concrete counterforts at varying intervals.

A heavy limestone coping was laid along the top, which was cramped with galvanized wrought iron cramps leaded in.

In the first Promenade constructed the height of the wall from the footing to the coping is 9 feet, and the average thickness 3 feet.

The maximum height of the sea-wall in Section No. 1 is 24 feet, and its average thickness about 7 feet, the minimum height being 12 feet, average thickness 4 feet. In Section No. 2 the maximum height is 21 feet 6 inches, average thickness 7 feet, the minimum being 10 feet, thickness 3 feet. In Section No. 3 the height of the wall averages 13 feet, and its average thickness is 4 feet.

The sea-wall for the latter three sections has all been founded on hard blue clay, which exists for the whole length; but the foundations of the sea-wall of the Promenade first constructed were not taken down so low owing to a desire for economy, which is now to be regretted.

The Promenade has been formed by filling up against the sea-wall as it was built up, and levelled according to sections, and the surface, after being consolidated, was asphalted or tarpaved, and has a slight inclination from the coping landwards of 1 in 18. The remainder of the surface was formed into a macadamised carriage-way and footpath, having suitable 12-in. kerbs and channels, and sufficient sewers were laid for draining away all surface water.

Wherever the height of the sea-wall above the Foreshore necessitated it, a tubular guard railing with cast iron standards, has been fixed to protect the public.

The width of the Promenade varies from 30 feet to 75 feet, and the carriage-way from 20 feet to 30 feet, the footpaths being 6 feet and 7 feet in width.

There were 24 tenders sent in for carrying out the three sections of the New Promenade, and they ranged from 30,049*l.* to 69,810*l.*; the Author's estimate being 36,054*l.*

Upon referring to the photographs hanging in the room the members will notice the great transformation that has taken place along the foreshore.

The Promenade now extends in a crescent form along the sea front for a length of over 2½ miles, and, as already mentioned, is efficiently lighted by arc lamps. Nine ornamental cast-iron shelters have been erected along the first Promenade, for the convenience of the public, and these have sitting accommodation for 40 in each. They are all lit up at night with electric glow lamps. Also 138 convenient seats, each accommodating 6 persons, are ranged along the whole of the Promenades.

The Author would point out that the erection of this long stretch of sea-wall has materially altered the character of the Beach, and in his opinion, has greatly increased the erosion. Much difficulty is now experienced from the shifting of the shingle, and loss of beach. The only protection which the Author has resorted to so far, is the erection of low timber groynes, which are placed at right angles to the face of the wall, and at a little greater distance apart than their own length; the cost of these runs out at about 10*s.* per lineal foot. Two groynes have been erected at an angle with the face of the wall, but these do not seem to answer as well as the others; and from the Author's inquiries it seems that the same remedial measures do not succeed everywhere. A great difference of opinion exists as to the kind, length and distance apart of such groynes, and also as to the direction in which the groynes should be erected.

General, and Conclusion.

The Author has still the prospect of a very busy time in front of him, as he has already submitted plans, etc., for a new Town's Yard and Depôt Premises, with Stables, Sheds, etc., and the Local Government Board have already sanctioned a loan of 1500*l.* for the carrying out of the same. The following matters have also been mooted from time to time:—Refuse Destructor, Public Slaughter House, Market Hall, Swimming

Baths, and a new large Service Reservoir, upon which he has already reported and submitted preliminary estimates.

The Author desires to take this opportunity of acknowledging the courteous assistance which he has at all times received from the members of his Council in his endeavours to carry out his onerous and multifarious duties, and he also expresses his gratification to the Association for the honour paid to the town and himself in holding a District Meeting here.

DESCRIPTION OF THE COLWYN BAY AND COLWYN URBAN DISTRICT COUNCIL'S NEW SEWERAGE AND SEWAGE DISPOSAL WORKS.

BY ROBERT GREEN, M.INST.C.E.

COLWYN BAY, with its many natural advantages, claims to be unlike most other towns as a health and holiday resort; and justly so, as the forethought of the Council has never permitted the sewage question to become acute. The significance of this will at once be apparent when it is recalled that the resident population of the district, according to the Census returns, was only 2418 in 1881; in 1891 it had increased to 4754, and to 8683 in 1901; whilst the present estimated population is over 12,700. The actual number of persons annually visiting Colwyn Bay is difficult to ascertain; but whereas in 1881 the number was small, at the present time, in the height of the season, the number is estimated at over 12,000.

With the population thus increasing by leaps and bounds, it was obvious that the time would soon arrive when it would be undesirable for the sewage to be discharged into the Bay from the three existing outfalls, the outlet ends of which were too close to the shore to enable the sewage to be discharged into the main currents.

Between 1894 and 1899 various sanitary works were carried out by Mr. William Jones, the Engineer and Surveyor to the Council; but in June, 1899, upon an application being made by the Council to the Local Government Board for sanction to borrow money for the sewerage of Pendorlan and Eirias Dingle, that body intimated to the Council that—

"In the opinion of the Board's advisers, it is most desirable, especially in view of the fact that the district is a popular

seaside resort, that the sewage should be entirely taken out of the Bay and discharged at some point on the north-west of Rhos Point, where it would be at once carried away by the main current without any risk of its being returned into the Bay. The existing outfalls should be retained for the discharge of surface water only."

A special meeting of the Council was held on July 18, 1899, when the Author's partner (the late Mr. Edward Pritchard) was retained to prepare a scheme of sewage disposal. He was in the midst of preparing a gravitation scheme (by which means he hoped to avoid the annual cost of pumping), when, on May 11, 1900, he unfortunately died.

On June 22, 1900, the Council appointed the Author as their Engineer, and Mr. Baldwin Latham as Consulting Engineer.

On August 24, 1900, the Council instructed the Author to prepare the pumping scheme forming the subject of this paper, which was duly submitted to them; and on July 3, 1903, a contract was entered into with Messrs. Underwood & Bros. for the Works, a commencement of which was made by them on the 23rd of that month.

The Author made extensive tidal observations for several months, with the following results:—

Highest High Water	**14·08 ft.**	**above O.D.**	**at 10.40 a.m. on April 19, 1901.**
Mean High Water	**9·834 ft.**	**"**	**from April 12 to May 4, 1901.**
Lowest High Water	**6·25 ft.**	**"**	**at 5.55 p.m. on April 13, 1901.**
Highest Low Water	**3·66 ft.**	**below O.D.**	**at 11.0 p.m. on April 12, 1901.**
Mean Low Water	**8·733 ft.**	**"**	**from April 12 to May 4, 1901.**
Lowest Low Water	**14·33 ft.**	**"**	**at 5.47 a.m. on April 20, 1901.**

On March 3, 1900, the level of high water was 14·71′ above O.D., and the level of low water 14·47′ below O.D.

On May 2 and 3, 1901, when the level of high water was 10′ 2″ above O.D. (which may be considered as a mean or average tide), the Author found that the tide fell 1′ 1″, 3′ 0″, 4′ 4″, 4′ 9″, 4′ 1″, and 2′ 5″ respectively in each of the six hours after high water; while in the six hours after low water the tide rose 9″, 3′ 7″, 6′ 0″, 5′ 6″, 3′ 9″ and 8″ respectively.

The Author also made comprehensive tests to ascertain the direction and velocity of the currents between Penmaen Head and Rhos at varying states of the tide; all the observations

taken in the vicinity of Penmaen Head and at the three existing outfalls proved that sewage discharged into the Bay could not be permanently and entirely carried away.

These observations also proved that there exists a main current (having a maximum velocity at the rate of 2·25 miles per hour) flowing past Penmaen Head and Little Orme's Head east and west alternately with the tides, that the only practicable position for the Sea Outfall sewer to discharge into this main current is at the place selected, and that sewage discharged into the main current at this point would be rapidly and completely carried away.

The levels of the outfall sewer originally fixed were such that the invert of the last pipe was at a point 16′ below O.D. However, as the Author found that considerable erosion had taken place in the bed of the sea between March, 1900, and August, 1903, this level was altered to 17′ below O.D., resulting in all the pipes excepting eleven being buried below the bed of the sea, their flanges being visible only once a year for about an hour.

This outfall sewer is of cast iron, 30″ diameter, in 12-feet lengths; those below low-water mark having turned, bored, and flanged joints fastened together with six $1\frac{1}{8}$″ diameter gun-metal bolts, and those above low-water mark having ordinary turned and bored joints. The extreme end portion, which has been laid with the pipes partly above the bed of the sea, will be carried on steel angle-bearers sunk in the ground and secured to steel H piles, angle-straps being fastened across the tops of the pipes.

The average rainfall recorded at Nant-y-Glyn (Colwyn Bay) during 21 years = 31·41″; and at Bryn Euryn (Colwyn Bay) over 25 years was 31·11″. In the calculations for this scheme the rainfall has been taken at 31·36″ per annum.

Under the old conditions the sewage was conveyed by branch sewers to three distinct outfalls, through which it was discharged into the Bay continuously at all states of the tide, thus dividing the whole district into three large drainage areas; but in order to avoid the flooding previously experienced, and to relieve the congestion which existed in certain parts of the district, the Author has divided the district into fifteen drainage areas, the sewage from which discharges into the new main Intercepting Sewer at twelve distinct points, spread over its

entire length and is conveyed to the pump well from which it is pumped into a covered Reservoir; the total lift being 44'.

The total length of the Sea Outfall, measured from the Reservoir, is 3779', the seaward end being 2000' below high-water mark, and 1530' below low-water mark of ordinary tides, and 2060' from the face of the sea wall.

The Council's Act of 1902, authorising the construction of these Works, provides that the sewage may be discharged through this Sea Outfall into the sea within a period extending from high-water to half-ebb (a period of about 3 hours), and that in the event of heavy rainfall or other emergency, not only sewage but also storm water may be discharged into the sea at any state of the tide through the new as well as through the three existing Sea Outfalls when the sewage is diluted in the proportion of four volumes of rain to one of sewage.

The discharging capacity of the Sea Outfall depends upon and varies with the height of the sea and the level of the sewage in the Reservoir, but under the worst conditions it is capable of discharging 2,151,000 gallons during 3 hours.

The Sea Outfall, under such worst conditions, is capable of discharging the whole contents of the Reservoir in about 42 minutes, and in about 2 hours, when the four pumps are giving a continuous supply to the Reservoir to the extent of their utmost capacity (at the rate of 7725 gallons per minute).

The interception of the sewage from the three old sea outfalls, and the conveyance of it to the pumping station, has been achieved by constructing an Intercepting Sewer along the sea front underneath the Promenade from Beach Road to Rhos Road, whence it is carried across private lands to the pump well, its diameter varying from 39" to 15", the invert level at the pump well being 0·10' below O.D., and at Beach Road 14·31' above O.D.; the sewer is practically 2·84 miles in length.

The lowest lying land within the district is adjoining the western boundary, and varies from 7·00' to 10·00' above O.D. The lowest built-upon land, except that immediately adjoining the sea, is near to the Gas Works, on the road to Mochdre, where it is 18' above O.D.

The portions from 24" to 39" diameter have been constructed of concrete 6" thick, with a lining of brindle brickwork 4½" thick, a cement collar joint ¾" thick separating the two materials.

The 18″ and 15″ diameter portions were constructed of glazed stoneware pipes.

Difficulty was found in arranging proper overflows from the main sewer, of which there are only four; the one at Beach Road being the only one which can be used at all states of the tide.

These four overflow man-holes are situated: (1) At Church Road, Rhos, where the level of the invert of the 39″ sewer is at O.D., and the overflow weir is 1·50′ above; therefore, assuming the maximum flow at any time to be at twice the rate of the average flow, this weir would not act until the sewage, at the time of the greatest flow, from a population of 23,712 was diluted to the extent of four to one; (2) At Rhos Road, where the invert of the sewer is 1·33′ and the overflow weir 3·65′ above O.D.; (3) On the West Promenade, where the levels are 4·39′ and 9·00′ respectively; (4) At Beach Road, where the levels are 14·31′ and 15·56′ respectively.

The overflow pipe in the man-hole at Church Road is connected into the Sea Outfall; it therefore cannot come into action at the time when the Reservoir is discharging. The other three overflows are connected to the old existing outfalls, which, as authorised by the Act, are retained for the sole purpose of acting as storm and surface water outlets.

So far as the subsidiary foul-water sewers are concerned, practically the only new work executed has been in connection with the diversion of the sewage to relieve congestion in certain places, and to carry into effect the new arrangements of drainage areas.

The existing sewers conveyed both surface and foul water. To reduce the annual cost of pumping, nearly 3 miles of surface-water drains have been laid. On the score of present economy, as small a gross length as possible has been constructed, their positions being chosen so as to collect the greatest amount of surface and subsoil water at the least cost.

Ventilation is partially provided by means of cast-iron columns showing the cardinal points of the compass 30′ high above the ground; all the new man-holes, excepting those in fields, are provided with closed covers.

The standard man-holes on the Intercepting Sewer are 5′ long, the width varying with the size of the sewer: those on the 33″ diameter sewer being 5′ 6″ wide. The majority are formed

in cement concrete, in the proportion of 5 to 1, and 12″ or 15″ thick at the bottom, according to the depth.

Where the ground was very wet, the man-holes were entirely constructed of brickwork in cement, the walls being 14″ thick in all, with a cement collar joint, so that the outside portion of the wall was 9″ thick and the inside 4½″. In all cases 12″ of concrete was laid below the 4½″ ring of brickwork forming the invert.

The man-holes on the Intercepting Sewer do not exceed 120 yards apart, while those on the pipe sewers are generally much closer together, and in addition, a lamp-hole is placed in most cases equidistant between and alternately with the man-holes, constructed of 9″ diameter pipes surrounded with cement concrete, a foundation of concrete being formed around and under the sewer immediately below.

Where incoming sewers at man-holes have been at a higher level than the outgoing ones, back-junction pipes have been built in the higher sewer, and an inclined drop-pipe laid outside the man-hole, surrounded and supported with cement concrete conducting the sewage into the man-hole at the invert level, the sewer at the higher level being continued straight into the man-hole to act as an inspection opening; a lip being formed in the back-junction to prevent the sewage from jumping the vertical pipe and entering the man-hole.

All pipe sewers over 12′ deep have been laid on and surrounded with 6″ of cement concrete to protect them from the pressure of the superincumbent earth.

The cement compo for making the joints of the pipes has been mixed in the proportion of two parts of cement to one of sand. Sea-shore sand has been used throughout the whole of the work, but fresh water was employed for mixing purposes.

Wherever the ground was wet, pipes with "Hassall's" joints were used for the foul-water sewers, the joints being also surrounded with clay puddle if the whole sewer was not concreted over.

Wherever practicable overflows have been constructed to the few internal sewers interfered with; in some cases a combined man-hole has been built with both the foul and surface water sewers running through it, and an overflow weir permitting the sewage when properly diluted to pass off by the surface-water drains. The majority of the overflows are ordinary side

weir ones, but where possible the sewer has been curved so as to give the sewage a lead over the weir. In the vicinity of Colwyn Bay Hotel there was originally an overflow weir at a level of from 4″ to 6″ above the invert of the 18″ diameter sewer, which had a gradient of 1 in 14; but notwithstanding the fact that at that time the whole of the sewage of Colwyn Bay passed through this pipe, the sewage, even in times of heavy rainfall, never rose sufficiently high to overflow. The length of sewer below this man-hole was taken up and a new 18″ diameter sewer constructed at a flatter gradient, the invert being lowered 4′ at the top end, and on the site of the old man-hole a new one with an adjustable leaping weir arrangement was constructed in readiness for connecting up to the surface-water drains which will have to be constructed in the vicinity at an early date. The plans for these, and the estimate of cost of the same, the Author has already submitted to the Council.

The three storm overflows upon the Intercepting Sewer, which are below the level of high water, are not only controlled by penstock valves, but have, in addition, tidal flap valves or reflux valves respectively fixed on the sea side of them in the overflow chambers, so that in the event of the penstock valves being inadvertently left open, the sea-water will be kept out of the sewers by the flap valves.

The penstock valves are of screw-down pattern, with worm gear, two gun-metal faces, forged bronze unbreakable spindles, gun-metal bush at worm gearing, and gun-metal wedges for tightening up. The extension spindles are forged of wrought iron. The flap valves are in one piece, hung on hardened steel pins working in gun-metal bushes, and fitted with lead seat and V faces, and are of the balance tidal pattern.

Inasmuch as the sewage of a large part of Colwyn Bay passes through the man-hole at the intersection of Princes Drive and Marine Road (which it was necessary to reconstruct), a gauging chamber measuring 7′ 3″ by 9′ has been constructed in connection with the new man-hole, which itself is 5′ 6″ by 5′.

All the sewage, whether diluted or not, is screened before reaching the sea. In every overflow man-hole a fixed vertical iron bar screen with $\frac{3}{8}$″ diameter bars, having a clear space of only $\frac{3}{8}$″ between them, has been provided, and at the inlet to the pump well a revolving screen, 12′ in diameter, with circular holes about $\frac{1}{4}$″ in diameter, has been fixed, and through

which the whole of the sewage has to pass before reaching the pumps. The screen consists of a circular casting, in the form of a channel, 12″ wide by 7″ deep by 12′ outside diameter. The centre is filled with perforated plates, which screen the liquid, the residual matter falling into the channel forming the periphery of the wheel, and, as the wheel revolves, slides along radial arms to the centre, where it is drawn by a revolving worm screw into a trough, from which it is lifted by a bucket elevator, and discharged, by means of a shoot, through the outer wall of the pump-room, into a tumbler cart, which is constantly in position under the outlet. The wheel is driven by spur gearing working into teeth cast on the outer edge of the face of the screen. There is a rubber lip at the edge of the screen, to prevent the sewage escaping around instead of through the screen.

The perforated plates are cleaned by the action of a spray pump, fixed on the down-stream side of the screen.

To lift the sewage from the pump well into the Reservoir, pumps, drivèn by gas-engines, have been installed. There are four units, all of the same type, two being capable of lifting at the rate of 420 cubic feet per minute, and two at the rate of 200 cubic feet per minute. Each pair is similar in all respects, and their parts interchangeable.

Each of the larger units consists of a treble ram pump, 26″ diameter and 26″ stroke, making 20 revolutions per minute, which give a ram travel of 87′ per minute. The suction pipe is about 12′ long and 20″ in diameter, the bottom being bell-mouthed and reaching to within 9″ of the bottom of the sump, the delivery pipe being of the same diameter. The spur wheel on the pump is 13⅜″ wide, and 7′ 7$\frac{1}{16}$″ diameter over all, and has 79 teeth 3½″ pitch. The pinion is 13½″ diameter over all, and has 10 teeth; it is secured to the extended end (4½″ in diameter) of the engine shaft, which is 6″ in diameter, and travels at the rate of 170 revolutions per minute. The B.H.P. is 64. The engine has two flywheels, each 6′ 9″ in diameter, 11″ wide, and weighing 38 cwts. each.

Each of the smaller units consists of 18″ by 18″ treble ram pumps, making 28 revolutions per minute, which give a ram travel of 84′ per minute. The suction and delivery pipes are 14″ diameter; the spur wheel is 9″ wide and 5′ 7″ diameter over all, and has 68 teeth 3″ pitch; the pinion is 11⅜″ diameter

over all, and has 10 teeth; the engine shaft is 4″ diameter, and the extension piece 3½″ diameter. The engine is 34 B.H.P., has two flywheels, each 5′ 6″ diameter, 7″ wide, and weighing 14 cwts. each. They run at 190 revolutions per minute.

An air-vessel is placed at the top of each suction pipe, as well as on the delivery pipes. Cast-iron reflux valves are fitted adjacent to the pump and at the foot of each rising main; the doors are of steel, in one piece, hung on hardened steel pins working in brass bushes, and have dermatine faces; the brass seating is renewable. Drain cocks, 1½″ and 1¼″ respectively, are fixed to the rising mains on the upper side of the reflux valve, for the purpose of emptying the mains when required. The pump valves are of the hinged type, with six leaves to each valve, and have also dermatine faces; they are hung on hardened steel pins working in gun-metal bushes. Four bearings are provided for each pump crank shaft, which are carried on cast-iron cross girders, the ends of which are machined to fit the shape of, and bolted to, the main longitudinal girders, which are 10″ wide by 30″ deep and 8″ wide by 27″ deep respectively. A Bridge's friction clutch is fixed on the extension shaft from each engine, which is worked by an hydraulic cylinder, with town water, which is actuated by a float, so that as the level of the sewage falls, the pump is automatically detached from the running engine, and, when the sewage rises, is automatically reconnected, if, in the mean time, the attendant has not stopped the engine. There is, in addition, a float with pointer attachment, which indicates on a board the water-level in the pump well, and is set to give an electric alarm when the sewage rises too high, or when the sump is empty. The pump pinions are of cast iron, with machine-cut teeth. The spurs are mortice wheels, with teeth made of beech.

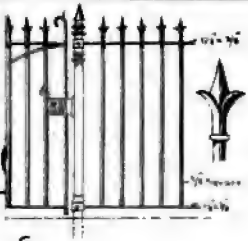
The gas-engines are of the single-cylinder horizontal "Otto" cycle principle of the "Campbell" type. They were tested before they left the Manufacturer's Works, with results which bore favourable comparison with the guarantees given by the Makers for the subsequent tests to be made at Colwyn Bay.

The Author stipulated, in the specification of the Works, that guarantees should be given, in consequence of which the Makers guarantee (on tests to be made at Colwyn Bay in the ninth month after the machinery has been run by the

PLATE No I.

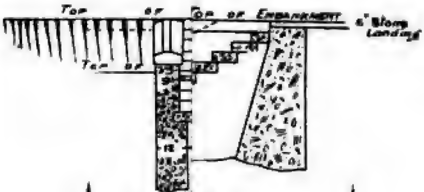
T COUN

KS.

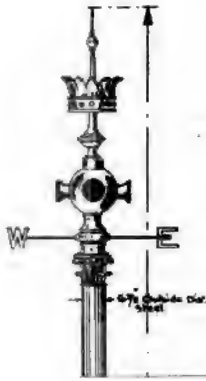


6

on Gate & Railing



5



Manufacturers for one month and certified to be in proper working order) that the consumption of gas by each of the four large engines when developing its maximum power (under a four-hours' continuous brake test) shall be 14½ cubic feet per brake horse-power per hour, and they agree to pay the Council a sum, calculated at the rate of 2 per cent. of the contract value of each and every engine, for each and every cubic foot or part of a cubic foot of gas consumed above the guaranteed amount, the specification providing that the Council, on their part, shall pay as a bonus a sum, calculated at the rate of 1 per cent. of the said contract value of the gas-engines, for each and every cubic foot or part of a cubic foot of gas consumed below the guaranteed amount; and the Makers guarantee that not more than 4½ cubic feet of gas shall be consumed per 1000 gallons of sewage raised, and have undertaken that if the consumption of gas by any of the four large engines exceeds 18 cubic feet per brake horse-power per hour at maximum power, they will replace the said engine or engines with others that will comply with the specification, without any cost whatever to the Council. The Colwyn Bay gas has a thermal heat value of 620 British thermal units per cubic foot.

Magneto-electric ignition is used on the engines. Automatic lubrication, which does not allow the oil to run to waste when the machinery is standing, is provided to all the principal bearings; in other cases syphon lubrication is adopted.

There are also two 5-B.H.P. engines in the engine-room, and one of 3-B.H.P. in the workshop.

The foundations for the whole of the seven gas-engines are composed of cement concrete, and for the four large engines they are joined up together so as to make a continuous block. The depth is 6′ under the 34-B.H.P. engines, and 7′ under the 64-B.H.P. engines, and the width tapers from 5′ 10½″ to 6′ 7½″ in the case of the former, and 7′ to 7′ 9″ in the latter. The foundations to the two 5-B.H.P. engines are 3′ 6″ in depth, and to the 3-B.H.P. engine, 15″. The starting apparatus is actuated by compressed air generated by the two 5-B.H.P. engines, which also drive the revolving screen, and is stored in a cylinder 2′ 6″ diameter and 8′ high.

The bearings are of phosphor bronze, and are generally proportioned so that the length is twice the diameter of the shaft. Each pump is fitted with a five-figure counter.

The two 5-B.H.P. engines are generally similar to the larger engines, excepting that they have only one flywheel, and are fitted with porcelain tube ignition. Their speed is 270 revolutions per minute, and they are expected to consume from 20 to 22 cubic feet of gas per hour. Two separate water tanks are provided for these 5-B.H.P. engines, 2′ 6″ diameter and 5′ 3″ high.

The pipe trenches under the floor of the engine-room are formed in cement concrete, and covered with wrought-iron chequer plates resting on cast-iron rails with machined faces. The air-inlet silencers are placed in similar receptacles under the floor. Separate exhaust pipes have been provided with exhaust silencers to each engine. The flooring of the pump-room at ground level (16·00′ above O.D.) between the pumps is formed of chequered iron plates $\frac{5}{16}$″ thick, laid on and secured to rolled steel joists; the remaining portion of it is finished with "*terrazzo*" paving. The lower pump-room floor is at a level of 4·50′ above O.D., and is formed with cast-iron grid plates $\frac{3}{4}$″ thick, supported by rolled-steel joists. The engine-room is paved with oak blocks. A 5-ton overhead travelling crane is fitted in both the pump-room and engine-room, on running rails fixed the full length of the building along the top of the piers which project in both rooms.

Special efforts have been made to render the working of the machinery as silent as practicable, so as to prevent annoyance.

Two cooling tanks have been fixed over the office and store; they are each 17′ by 8′ and 5′ 6″ deep, having a capacity of 8700 gallons up to overflow level, which is sufficient for a 12-hours' continuous run of not only the present plant, but also for a fifth unit. The fresh-water supply pipe is connected to the cooler of the two tanks, and is 1″ in diameter, being regulated by a ball cock; the cool-water supply to the engines is taken off at a height of $6\frac{1}{2}$″ above the bottom of this tank; and the hot-water returns from the engines are in duplicate, and connected to the other tank at a height of 4′ 9″ above the bottom. The connection between the two tanks is by a 6″ pipe reaching nearly to the bottom of the latter one, and discharges at the top of the cooler tank; the overflow is $1\frac{1}{2}$″ in diameter, and is 5′ $1\frac{1}{2}$″ above the bottom. Circulating pumps are fitted to each of the four large engines, to assist the flow.

The castings for the cylinders and other hard-wearing parts

have been cast from the best cylinder close-grained mottled-grey iron, as hard as could conveniently be tooled. All metal used in the castings had a tensile strength of at least 7 tons per square inch, with a transverse strength such that a 3′ 6″ bar, 1″ wide by 2″ deep, supported on points 3′ apart, bore a load of 30 cwts. for 24 consecutive hours, with a minimum deflection of ¼″. The pump and cylinder castings were tested to an internal water pressure equal to 500′ head before being machined.

The whole of the steel was manufactured by Siemen's Martin open-hearth acid process, and is of a good mild malleable quality. It withstood the specified tensile strain of not less than 28 tons, or not more than 32 tons per square inch, and had an elongation of not less than 20 per cent. in a length of 8″. Strips 1½″ wide and 1″ thick heated to a low cherry red and cooled in water at a temperature of 80° Fahr. were satisfactorily bent in a press to a curve of which the inner radius was 1½″.

Although only four pumping units have been laid down, space has been left for the provision of a fifth, as the whole of the present plant working together can only deal with the full amount of sewage the Intercepting Sewer can convey to the pump well.

A well-equipped workshop, 24′ by 20′ 6″, paved with granocrete, has been constructed adjoining the pump-room. The lathe is an 8″ self-acting sliding, surfacing, screw-cutting, gap-bed lathe, capable of taking a length of 9′ 6″ between the centres. The drilling machine is capable of taking drills up to 1½″ diameter. The pipe and bolt screwing machine has adjustable dies from ½″ to 1½″, and for pipes from ⅜″ to 1½″ in bore. There are also a 36″ diameter grindstone, anvil, forge, and a "Root's" blower. The whole are worked by the 3-B.H.P. gas-engine. There is also a work-bench fitted with cupboards under.

The pumping station is a building of an ornate character, built in Ruabon red bricks with yellow terra-cotta facings, copings, and enrichments; the engine-room is 100′ long and 12′ 6″ wide between the piers; the pump-room is also 100′ long by 21′ 4″ wide between the piers. There are two annexes to the main building, one forming the workshop and the other containing the entrance lobby, office, and store and meter rooms. The office is 11′ 2″ by 15′ 10½″, and is paved with oak blocks,

the walls being plastered and painted. The meter-room is 22′ by 11′ 2″, with granocrete floor, and the walls whitewashed on the brickwork; it contains two 600-light meters, through either or both of which the gas passes to drive the pumping engines and the workshop engine and a 40-light meter separately connected to the main for lighting purposes. Cupboards for store purposes are fixed under the meters, and in other parts of the room are shelves, bins, and pigeon-holes. The gas supply for the two 5-B.H.P. engines driving the screen and air compressors is taken separately off the main, and is measured through a 30-light meter placed in the engine-room adjoining them. The gas main is 6″ in diameter.

The walls of the engine and pump rooms have been finished with a glazed brick dado 4′ high, above which the walls are painted with duresco. Large folding doors have been provided to facilitate the entry or exit of any of the larger parts of the machinery. The piers are built 16′ 8″ centres, and the iron roof principals are 8′ 4″ apart. The cement concrete pump-well walls are a minimum of 3′ thick at the top, and are 5′ 5″ thick at the bottom. On the south and west sides they are 4′ and 4′ 3″ thick at the top, owing to the inside face being required to be vertical between the two floors.

The roofs have been covered with $1\frac{3}{4}''$ diagonal boarding, on which has been laid roofing felt and $1\frac{1}{2}''$ by $\frac{3}{4}''$ slate laths. The slates are seconds best quality from the Bettws-y-Coed district, 20″ by 10″, laid with a 3″ lap. Louvre ventilators have been fixed in the roof of the pump-room, while on the engine-room roof five "Stott's" ventilators have been fixed; there are also air inlet gratings 9″ by 9″ fixed in each of the outer walls.

A fixed louvre ventilator runs the full length of the roof over the cooling tanks, and in the walls of the portion of this building above the level of the office ceiling, two rows of open spaces have been formed, 9″ wide by 2′ 9″ high, placed 9″ apart in order to render the circulation of air free around the tanks.

The Reservoir is 83′ 5″ by 82′ 4″, and holds an average depth of 12′ of sewage, having a total capacity of practically half a million gallons. It is formed of 5 to 1 cement concrete, covered with groined semicircular arches 9″ thick, supported on piers 2′ 6″ square; the walls taper from 2′ thick at the top to 4′ 6″ at the bottom, and the floor itself is 3′ thick. At every 2′

in height of the walls, five continuous lines of hoop iron are fixed on edge, and in the floor there are lines of hoop iron laid on edge 12″ apart both lengthwise and crosswise. The spandrils have been partly filled in with cement concrete, on top of which have been laid 12″ of gravel for drainage purposes, from which 2″ diameter field pipes have been laid through the arches for carrying off the rain-water. The whole of the interior and of the valve chamber, as well as the exterior of the arches, have been rendered $\frac{3}{4}$″ thick with cement mortar put on in two coats.

Two man-holes have been formed in the roof of the Reservoir at opposite corners; wrought-iron ladders, $2\frac{1}{2}$″ by $\frac{1}{2}$″ strings, and $\frac{7}{8}$″ diameter rungs 12″ apart, have been built into the walls to a depth of 12″, and into the floor 6″.

The floor at the corner diagonally opposite to the outlet is at a level of 27·50′ above O.D., or 3′ above the level at the outlet corner, and there is a fall from the highest point of 18″ in the length of each side wall, so that it falls in all directions to the sump, 3′ deep, from which the discharge takes place at a level of 21·50′ above O.D.

The four cast-iron rising mains (two being 20″ and two 14″ diameter) enter the Reservoir at a level of about 6″ above the floor; in addition a fifth pipe, 20″ in diameter, has been built in, in readiness for the connection of the rising main from the proposed fifth pumping unit when the same is laid down.

All pipes built through the Reservoir walls below water-level have been formed with a projecting flange around the body of the pipe, to prevent the sewage creeping along them.

The height of the overflow weir or top water-level is 38·00′ O.D. This weir is 5′ wide and 18″ in height at the sides, and 2′ in the centre, and is formed in the wall between the Reservoir and the valve chamber. In the outer wall of this valve chamber a 30″ diameter cast-iron emergency overflow pipe has been built in at a level of 35·50′ O.D., so that the top of the pipe is just level with the overflow weir, and is connected to the 30″ diameter Sea Outfall a few feet away from the valve chamber.

The discharge from the Reservoir to the Sea Outfall is controlled by a 30″ diameter penstock valve, actuated by gearing from the valve chamber platform. Immediately behind this valve is a chamber, 4′ by 7′ 6″, in the opposite wall of which is built the end of the 30″ diameter Sea Outfall

pipe, also controlled by a penstock valve, which is intended to be kept fixed about half open, so as to throttle the flow of sewage, in the event of the other valve being opened too quickly.

The platform over the valve chamber and the entrance to the Reservoir is paved with 6″ stone slabs, and surrounded with a cast-iron railing and gate. It is approached by a flight of concrete steps, formed in moulds and subsequently built into supporting walls of concrete.

Four ventilating columns, similar in design to those fixed to the new sewers, have been erected near to each of the four corners of the Reservoir.

The contractors were not allowed to commence the excavation for the Reservoir until the pump well and the sewers within 800 yards of the Reservoir were completed, and all pumping in connection with them stopped.

As the Reservoir valve will, under normal conditions, be closed for periods of practically 10 hours' duration, storage for the greatest quantity of sewage which can be received by the sewers during such periods has been provided.

In addition to the storage in the Reservoir, there is that afforded by the capacity of the pump well and of the Intercepting Sewer, giving at least another 450,000 gallons, thus making a total storage capacity of approximately 950,000 gallons. The Author has advised the Council that, as the population increases, it will be necessary to construct a second Reservoir in the space reserved for the purpose. The maximum storage of sewage proper will only be required when the height of the tide necessitates the valve on the 30″ diameter Sea Outfall being closed immediately preceding the commencement of the maximum 10-hours' period of pumping.

A residence for the engineer in charge of the pumping station has been erected near the Reservoir. It contains a parlour, kitchen, scullery, pantry, three bedrooms, bath-room, and w.c. The main rooms are 13′ by 12′ by 9′ high. Both hot and cold water are laid on to the bath, lavatory basin, and sink. The outbuildings contain compartments for coal, ashes, and a w.c.

The land owned by the Council contains an area of about 5 acres, the boundary wall of which is built of random rubble in lime mortar, pointed both sides in cement mortar; that facing Church Road is 6′ high above the surface of the ground and surmounted by a castellated coping 7″ and 12″ in depth;

the thickness is 21″ at the bottom, and 15″ at the top, the whole of the batter being on the inner side. The entrance gates are of pitch pine, and give a clear width of 10′ 6″ between the piers.

The actual Works have cost a sum of practically £62,000.

The Council's Act authorises them to pay off the money required for these Works (not exceeding £68,000) within a period of 45 years from the dates of borrowing the same.

The Author does not consider this Paper would be complete unless he bore testimony to the valuable assistance he received from Mr. Baldwin Latham in the preparation of the scheme, to the utility of the information supplied to him by Mr. William Jones (the Engineer and Surveyor to the Council), to the co-operation of the Author's chief assistant (Mr. Henry C. Adams), and of his staff generally, to the manner in which Mr. C. T. L. Bristow has performed his duties as Resident Engineer, and Mr. Rice-Jones as Assistant Resident Engineer, and to Messrs. Underwood & Bros., the contractors, and Messrs. Campbell Gas-Engine Co., the manufacturers of the machinery, for the satisfactory manner in which they have carried out their respective works.

Now that the Bay is devoid of all suspicions of pollution by sewage matter, it is one of the finest bathing-grounds in the country, and, as the sewage is discharged at a depth of from 17′ to 31′ (whether neap or spring tides) at a velocity of about 4½ miles per hour, into a large body of sea-water forming part of the main current, it at once becomes purified by the mixing action of the sea-water, and being carried by the current right out to sea, there is no possible danger of its ever returning to the shore or of causing nuisance or annoyance to anybody.

In conclusion, the Author congratulates the Council upon their enterprise in the adoption and completion of such a system of sewage disposal, which, he has no hesitation in saying, enhances the value of Colwyn Bay as a health resort, and justly entitles it to the privilege of claiming that it is not only a very desirable place to reside in, but that it is also one of the most popular places for visitors to frequent who seek rest and pleasure in a pure, bright atmosphere and healthful, attractive surroundings.

COLWYN BAY WATER AND GAS UNDERTAKINGS.

By T. B. FARRINGTON, Assoc.M.Inst.C.E., Engineer to the Conway and Colwyn Bay Joint Water Supply Board.

Colwyn Bay Waterworks.

The town of Colwyn Bay came into existence about 1865, when Sir John Pender purchased a part of the Erskine Demesne, and proceeded to develop it as a Building Estate. For this purpose a water supply was necessary, and in 1867 a small reservoir of a capacity of about 150,000 gallons was constructed at Rhiw, about 200 feet above O.D. mains, and services were laid from time to time as required. During the next ten years some eighty houses were erected, and in 1875 the population was about 400. At this time the estate was acquired by the Colwyn Bay and Pwll-y-Crochan Estate Co., and about 1877, the development proceeding at a more rapid rate, the existing water supply became inadequate, and an additional reservoir of a capacity of about 450,000 gallons was constructed by the author at Rhiw alongside the old one, which was enlarged to a capacity of about 300,000 gallons, making a total capacity of 750,000 gallons. In 1878 the Colwyn Bay Waterworks Co. was formed, and the author was instructed to prepare the necessary plans for an application for parliamentary powers to carry out new works. The Act, obtained in the following year, authorised the construction of a pumping station at Groes Mill, 130 feet above O.D., and a large impounding reservoir above Pwll-y-Crochan Woods at an elevation of 600 feet above O.D. Only the first named of the above works was constructed, and water was raised from the Groes stream by steam pumps through a 6-inch rising main into the existing reservoirs at Rhiw.

These arrangements sufficed for the supply of the district until 1886, when the works were purchased from the Company by the Conway Rural Sanitary Authority. Up to this time the local affairs of Colwyn Bay had been administered by a Parochial Board appointed by the Conway Rural Sanitary Authority, but in 1887 Colwyn Bay was formed into a Local Board district, embracing Old Colwyn, Rhos, and other outlying portions. The plans of the district were prepared by the Author for the new Urban Authority. There was a total population at this time of about 3800.

A further supply of water being urgently needed, arrangements were made with the Llandudno Commissioners for them to provide it from their mains near Llandudno Junction, and the Author was instructed to lay about 4 miles of 6″ pipes to convey the water to Colwyn Bay. The population continuing to increase at a rapid rate, an augmented supply of water had again to be sought for, and in 1890 it was decided to join with the Borough of Conway and the Conway Rural Sanitary Authority in procuring such a supply as would meet the necessities of all three Authorities. Plans were prepared by the Author for obtaining a supply from Lake Cowlyd, and the Conway and Colwyn Bay Joint Water Supply District was constituted by virtue of the Provisional Order of the Local Government Board, dated the tenth day of June, 1891, "for the purpose of procuring a common supply of water for the constituent districts." The required works were then proceeded with, and the following is a description of the same.

The common supply of water for the constituent districts is obtained from Llyn Cowlyd, which is a natural lake, situated in the heart of the Carnarvonshire range of mountains, about 18 miles from Colwyn Bay, 3 miles from Trefriw, and 2 miles from Capel Curig.

Its extreme length is nearly $1\frac{3}{4}$ miles, and its extreme width over a quarter of a mile. The surface of the lake is 1169 feet above O.D., and has an area of about 200 acres. The watershed, which has an area of about 1100 acres, is free from human habitation or cultivated land, and rises precipitously on one side to a height of 2621 feet above O.D. (Pen Llithrig-y-wrach), and on the other side to a height of 2213 feet above O.D. (Cregiau Gleision). It is closed in at the Capel Curig

end by a slighter elevation of about 1450 feet above O.D. The natural outlet of the lake is at the north-eastern end.

The rainfall at Cowlyd for the last sixteen years, 1891 to 1906 inclusive, was as follows, as registered by an 8-inch gauge, 1 foot 3 inches above the ground, and 1168 feet above O.D.:—

1891 ..	92·91 inches	1899 ..	73·90 inches
1892 ..	72·55 „	1900 ..	84·90 „
1893 ..	68·20 „	1901 ..	73·30 „
1894 ..	76·80 „	1902 ..	63·90 „
1895 ..	66·50 „	1903 ..	114·30 „
1896 ..	66·10 „	1904 ..	80·60 „
1897 ..	73·50 „	1905 ..	74·40 „
1898 ..	58·50 „	1906 ..	85·50 „

This gives an average annual rainfall for the sixteen years of 76·61 inches.

Proof that the water is most excellent for domestic use is furnished by the analysis of which the following is a copy:—

"I hereby certify that the sample of water received by rail on the 5th day of March, 1891, yields on analysis the following parts per 100,000.

	This is very pure water.
Mark and denomination of the sample	Cowlyd Lake
Total solid matter in solution	3·48
Organic carbon, Organic nitrogen	Traces only
Ammonia	0·003
Ammonia from organic matter by distillation with alkaline permanganate	0·003
Nitrogen, as nitrates and nitrites	0·000
Combined chlorine	0·9
Hardness: temporary, „ permanent	Exceedingly soft
„ total	clear, colourless, neutral reaction, no deposit

"As witness my hand, this 14th day of March, 1891.

(Signed) J. CAMPBELL BROWN, D.Sc.,

"A. S. University College, Liverpool."

The compensation water to be delivered into the stream is 1,552,500 gallons during every working day of 12 hours, and a sufficient supply for cattle on the seventh day. To secure this amount of water, together with that required for the supply of the district, there was constructed across the end of the Lake an embankment which is 176 yards in length, and which impounds 14′ 0″ of water, or about 800,000,000 gallons.

The central portion of the embankment is formed of earthwork. It has an inner core of concrete, and the end portions have

inner puddle walls. Both the concrete core and the puddle walls, which are keyed into each other, are carried down into impervious strata. The inner slope of the embankment is 3 to 1, and the outer slope 2 to 1, the inner slope being pitched with stone grouted with cement, and the outer slope revetted with grass. There is a roadway along the top of the embankment 9′ wide, and a storm wall at the top of the inner slope 4′ high. The top water-level of the lake is 4′ below the level of the top of the bank. The waste weir is 30′ wide and formed of concrete, the inner slope being pitched with masonry grouted with cement. The overflow cill is of Yorkshire flags, and the outer side of the overflow is formed into steps with a tumbling bay at foot, and has rubble stone side walls, with ornamental piers and caps at foot of the inner and outer slopes of the overflow. The waste weir is crossed by means of a lattice girder bridge of 30′ span, continuing the roadway along the top of the bank.

The water is drawn from the lake through a cast-iron standpost 18′ high and 3′ internal diameter, with two 24″ valves, at 7′ and 14′ below the top water-level, regulated by gearing from the top of the standpost. Owing to the peculiar configuration of the bottom of the lake at the embankment end, it was found necessary to erect the standpost at a distance of 282′ from the embankment, and it is approached by means of a lattice girder bridge supported on cast-iron columns with diagonal bracing, and has six spans of 42′ and one of 30′. The standpost and the columns supporting the girder bridge are securely bolted down on concrete bases.

Water is drawn from the lake through s. and f. cast-iron pipes, 24″ internal diameter. These are laid from the standpost, a distance of 492 yards, to the gauge chamber.

The gauge chamber is a stone building 1154 feet above Ordnance datum, 26′ by 25′, with a slate roof, and is of very substantial construction. It contains the necessary machinery for controlling the supply of water to the district, and for regulating the compensation water which is delivered at this point into the stream. The water from the 24″ pipe is first of all discharged into an open tank, and passes through submerged orifices into a second tank, the object of this being to break the velocity of inflow. From this second tank the compensation water is delivered through an orifice into a cast-iron trough

2′ wide, over a test basin into the stream. Owing to the supply of the compensation water not being constant, it was necessary to devise some special arrangement for controlling the quantity delivered, and this is done by means of a notch-plate and penstock. There is a tumbler in the trough, by means of which the water can be diverted instantly at any time into the test basin and accurately measured. From the second tank the water for the supply of the district passes through screens having a fine copper mesh into a third tank, and is controlled by a 15″ valve with grating. The tanks are constructed of concrete. The inflow and outflow of all water for compensation and for the supply of the district are controlled by means of valves and penstocks with indexes, enabling an ordinary workman to regulate the quantity at any time. Should necessity arise, special provision is made by means of pipes, valves, and by-pass for delivering the compensation water into the river at a point between the gauge chamber and the lake, and for a supply for the district past the gauge chamber.

From the gauge chamber the water is conveyed in stoneware pipes a distance of 4,100 yards down the valley to the overflow tank 750′ above Ordnance datum. The pipes are double lined 15″ and 12″ internal diameter according to inclination, with brickwork inspection chambers, having cast-iron self-locking covers at every change of inclination or direction. The gradients vary from 1 in 11 to 1 in 137.

The overflow chamber near Tai Isaf Ardda is constructed of brickwork in cement with cast-iron self-locking cover. From the overflow chamber for a distance of 550 yards the water is conveyed in cast-iron pipes, 12″ internal diameter, to the pressure relieving tank at the top of Dolgarrog Woods, 500′ above Ordnance datum, from which the supply to the district is drawn. There is a by-pass arrangement at this point. The total length of pipes from lake to the pressure relieving tank is about three miles. The supply to the district is regulated by means of a special valve, and any surplus water coming down from the lake is forced back and discharged into the stream at the overflow chamber, 750′ above Ordnance datum, this being one of the conditions arranged with the riparian owners, so that the water discharged at this point can be utilised for other purposes.

There was no proper cart-road to the lake, and great difficulty

was experienced in getting materials to the site. Special sledges had to be used, and in many parts hauled along by blocks and ropes. Owing to the steep approaches, horses could not be used for the purpose. At Dolgarrog an incline was made 700 yards long from the main road, which is 20′ above Ordnance datum, to the top of the woods, 670′ above Ordnance datum, and materials were hauled up by means of a tank filled at the top of the incline with water of a sufficient weight to counterbalance and haul up an empty tank and 10 cwt. of materials; the full tank on arriving at bottom of incline was emptied and the positions reversed. From the top of incline to the lake the ground was soft and boggy, and everything had to be transferred on sledges.

The greater part of the work from the lake to the relieving tank is constructed in very boggy ground filled with large boulders. Several streams had to be crossed, and in some cases iron pipes were used for this purpose. A footpath has been formed along the pipe line from the lake to pressure relieving tank, and stiles fixed at all walls and fences.

From the pressure relieving tank the water flows in s. and f. cast-iron mains, 12″ internal diameter, through Dolgarrog Woods for a distance of 500 yards to the main road, at an average gradient of 1 in 3. In some places the pipes are almost perpendicular, and special anchorages were constructed at such points, consisting of iron straps bolted to the rock and masonry in cement abutments and supports. All the works to this point were constructed on private lands, for which easements were acquired in some cases with great difficulty and after much litigation. The line of 12″ cast-iron pipes is continued along the main road, with a few slight deviations, through Talybont, Tynygroes, Groes Ynyd, Gyffin, Conway, Llandudno Junction, Penybont, Sarn Mynach and Colwyn Bay to Pwllycrochan Avenue, and from there is continued in 9″ cast-iron pipes through Colwyn Bay and Colwyn to Llysfaen, a total distance of over 18 miles from the lake.

Wash-outs of 6″ internal diameter with valves are fixed at the lowest points of the main, and double air-valves are fixed at all the highest points. Hydrants and sluice-valves are also fixed at numerous places along the line, all of which are indicated by cast-iron name-plates.

The whole of the cast-iron pipes were tested at the works to

a pressure of 400 lbs. to the square inch, and afterwards tested on the ground before laying.

The various Authorities entitled to the supply have connections for this purpose at Gyffin, 4″; Conway, 6″; Old Llandudno Junction for Deganwy, 6″; New Llandudno Junction, 4″; Penybont, 4″; Pensarn for Pydew, 4″; Llangwstenin and Penrhyn, 4″; Sarn Mynach for Colwyn Bay and Llysfaen, 12″. Deacon Waste Water meters are fixed upon the branches for Gyffin, Conway, Deganwy, Pydew, Llangwstenin, Penrhyn, Colwyn Bay and Llysfaen. Ordinary meters are fixed upon all other branches.

The following special works were constructed along the pipe line from Dolgarrog:—

At Porthllwyd a girder bridge, of 45′ span with masonry piers in cement, was erected over the Afon Porthllwyd for the purpose of carrying the pipes; and at Talybont a similar bridge 38′ span was built over the Dulyn stream.

The most important of the special works is at Conway, where the pipes are carried over the River Conway by means of a steel wire rope suspension bridge, at a height of 20′ above highest spring tides, 326′ span, erected between the Conway Tubular and Suspension Bridges. The masonry in the pier abutments is of Anglesey limestone, moulded to match the existing structures. The piers are of lattice form, braced together with cross girders. There are three cables at each side of the bridge, carried over rocking quadrants on top of piers, the two outer cables being $1\frac{3}{4}''$ in diameter, and the inner cable $2\frac{1}{4}''$ diameter. From these the platform is suspended by means of rods $\frac{3}{4}''$ diameter, fixed alternately to the two outside cables and the inner cable by special clips, the bottom of the rods having small T cross-girders diagonally braced with eyes at each end, through which the suspension rods pass with nuts underneath, so that the length of the rods can be regulated. Channels are fixed 6′ apart on the cross girders and in which the wood platform is constructed. The two lines of steel cables are 18′ apart at the piers, and are drawn in at the centre of the bridge to 9′ apart, the object of this being to make the bridge as rigid as possible and prevent swaying. The platform is 6′ wide, and carries two lines of pipes of 9″ internal diameter, with expansion joints at each end of the bridge. The cables at each end are attached to forged steel

rods, carried down into anchorages in the solid rock, and bolted through bed plates secured with concrete. The whole of the metal used in the construction of the bridge is steel.

At Llandudno Junction the pipes are laid in a brick culvert underneath the Llandudno Branch of the London and North Western Railway. At Pensarn the main line of railway is crossed by means of a tubular girder in which the pipes are laid.

The total cost of the works which were designed and carried out by the Author, including purchase of Lake and Watershed, easements, etc., is 55,000*l.*

In order to supply the higher levels of Colwyn Bay a pumping scheme has been carried out by Mr. Wm. Jones, Assoc.M.Inst.C.E., which is fully described in his paper.

A somewhat similar scheme was previously designed and constructed by the Author for the supply of the higher parts of Llysfaen. These works include a pumping station at Old Colwyn, with gas-producer plant, engine, and pumps capable of lifting 5000 gallons of water per hour 580′ high through about 1½ miles of rising main 6″ internal diameter to a covered concrete service reservoir. The total cost of the works was about 8000*l.*

Owing to the unflagging growth of the population of Colwyn Bay, the Joint Board find the present main insufficient for the requirements of that town, and they have applied to the Local Government Board for powers to borrow 25,000*l.* for the purpose of laying down an additional main, 15″ in diameter, from Cowlyd Lake to Colwyn Bay. By direction of the Board the route for this new main has been surveyed by the Author, who has prepared the plans for the scheme.

Colwyn Bay Gasworks.

The first attempt at street lighting in Colwyn Bay was made in 1879, when a dozen lamp pillars with oil lamps were fixed by the Parochial Board, and in 1883 this number had been increased to thirty. In October of the latter year the Author was instructed by the promoters of the Colwyn Bay Gas Co. to secure a suitable site and to prepare the necessary plans for an application to Parliament for a Provisional Order to authorise the construction of gasworks for Colwyn Bay and

District. The present site was arranged for and the Provisional Order obtained in the following year, 1884, and the erection of the works proceeded with.

The following is a short description of the original works:—

Retort house, five retorts, one scrubber, two condensers, two purifiers, 6′ by 6′, station meter, gas holder (15,000 cubic feet).

A trunk main, 6″ diameter, was laid to Colwyn Bay, a distance of about 1½ miles, and this was continued by a 5″ main to Old Colwyn, a further distance of about 1½ miles, and a few branch mains, mostly 2″, were laid. The total cost of the works was about 5000*l.* The total make of gas for the first year being 1,583,000 cubic feet. The price of gas 6*s.* per 1000 cubic feet. There were forty-one consumers, and forty-two public lamps charged at 30*s.* per lamp.

In 1896 an Act of Parliament was obtained authorising the raising of additional capital, etc.; the Act also having a clause enabling the Urban District Council to purchase the works within five years by agreement or arbitration. The works by this time had been enlarged by the addition of thirty-seven retorts; two purifiers, 10′ by 6′; gas holder, 60,000 cubic feet capacity; exhauster having a capacity of 5000 cubic feet per hour; and a Cornish boiler. The total length of mains was about 6½ miles; total make of gas 20,000,000 cubic feet; about 380 consumers; gas for lighting, 4*s.* 2*d.* per 1000 cubic feet; cooking and power, 3*s.* 4*d.* per 1000 cubic feet; and 138 street lamps at 32*s.* 6*d.* per lamp.

Since 1897 the progress of Colwyn Bay has been unexampled in its rapidity, and constant extensions of the gasworks have been required. During this period the whole of the works and the mains have been practically remodelled and reconstructed. The following is a description of the works as they now exist, from which the reader may obtain an idea of the remarkable advancement of the undertaking:—

Retort house, containing sixty-six retorts; four purifiers, 12′ by 12′; two ditto, 10′ by 6′; three gas holders, capable of storing 15,000, 60,000, and 225,000 cubic feet respectively, a total of 300,000 cubic feet; two exhausters, having a capacity of 30,000 and 15,000 cubic feet per hour respectively; two scrubbers, one 45′ by 6′ and one 20′ by 4′; four annular condensers of a capacity of 300,000 cubic feet per day; station meter, for 20,000 cubic feet per hour; two 12″ patent

water-loading governors, one for low level and one for high level supply; cast-iron underground tar and liquor tank, capacity 150 tons; lifting pump and two boilers. The largest gasholder was constructed in 1900.

An additional trunk main of 12″ diameter has been laid to Groes, a distance of about two miles, and joined to the old 5″ main to Old Colwyn. A new 12″ trunk main, about a mile in length, has been laid to Llandrillo, and extended by a 9″ main about half a mile to the new sewage pumping station at Rhos. The total length of trunk and other mains is about 23 miles. Last year the total make of gas was 62,000,000 cubic feet. The average candle power is 17. Gas for lighting, cooking, and power is charged at 3*s.* 4*d.* per 1000 cubic feet; and for public lighting, 350 lamps, and all Council purposes, 2*s.* per 1000 cubic feet. The total capital of the works to date is 74,260*l.* The number of meters fixed is as follows: ordinary meters, 696; slot meters, 1150; cookers on ordinary meters, 178; cookers on slot meters, 850.

The following additional works have been arranged for: siding from railway, coal store, elevator, coal crusher, additional Livesey washer, mains, meters, cookers, and services; and a loan of 17,000*l.* has been sanctioned for these purposes. Larger purifiers are also contemplated.

In 1899 electric light works were started by the Council, and that undertaking has advanced and prospered side by side with the gas works. The Council purchased the latter works by arbitration in 1901 at a cost of 65,000*l.*

The following is a table which may be of interest to the members as indicating the progress made:—

Year.	Gas made in cubic feet.	Coal used in tons.	Gas made per ton of coal in cubic feet.	Coke per ton of coal for sale.	Price of gas for lighting and power per 1000 cubic feet.
					s. *d.*
1885	1,500,000	200	7,500	6 cwt.	6 0
1896	20,000,000	2200	9,000	8 „	4 2
1906	62,000,000	5600	11,000	10 „	3 4

Year.	Public lamps each per annum.
	£ *s.* *d.*
1885	1 10 0
1896	1 12 6
1906	2*s.* per 1000 cubic feet by meter

P

The whole of the gas now supplied for public lighting and other Council purposes is charged at 2*s.* per 1000 cubic feet. There are 120 incandescent lamps and 30 flat flame; but the latter are being replaced by incandescent.

The Author is indebted for the whole of the information respecting the works for the last ten years to Mr. John C. Pennington, the engineer and manager, who was appointed in 1897, and to whose energetic and efficient management the progress made to a great extent is due.

AN ACCOUNT OF THE PROGRESS OF THE ELECTRICITY UNDERTAKING AT COLWYN BAY.

BY A. R. TUDMAN, A.M.I.E.E.

IT is the Author's intention to deal with the growth and development of the Council's Electricity Works, which are situated in the centre of the town, in a street known as Ivy Street.

The Council obtained a Provisional Order in 1896 for the purpose of lighting the Promenades and private supply.

In 1898 the Council erected on the East Promenade 24 arc-lamps, 12 ampere, open type. The columns are 25 feet high, and of a very handsome design. The current was supplied by a 25 B.H.P. gas-engine, driving by belt a 2-pole, 15-k.w. dynamo. The lamps were connected 12 in series.

In the autumn of 1899 the Council put down a plant to supply current for private consumers, comprising a 60-k.w. steam dynamo, direct-coupled, and a boiler capable of evaporating 4000 lbs. of water per hour; a battery of 252 accumulators, capable of giving 100 amperes for 1 hour, or 25 amperes for 8 hours.

The supply for private consumers commenced on January 1, 1900.

This plant proved to be too small, and in 1901 the Council deemed it necessary to put down a larger plant, which consisted of a boiler capable of evaporating 9500 lbs. of water per hour, and a steam dynamo, 6-pole, direct-coupled, developing 120 k.w.

In 1902 the Council put down a duplicate steam dynamo of 120 k.w., as the consumption was increasing very considerably.

The spring of 1906 called for a further extension, and the

Council decided to put down a 120-k.w. steam dynamo, a water-tube boiler, and a condensing plant.

The boiler is capable of evaporating 9500 lbs. of water per hour; the condenser is of the barometric type, and is capable of dealing with 25,000 lbs. of steam per hour with a 27-inch vacuum.

The switchboard is enamelled slate, with Nalder instruments.

The total capacity of the Works is 420 k.w., the system being 3 wire, continuous current, 440 volts between the outers, and 220 volts between one outer and middle.

Part of the public lighting is done by arc lamps—the main thoroughfares and Promenades.

The Promenades from Rhos Pier to Old Colwyn Viaduct have 66 lamps, at distances ranging from 65 to 90 yards apart, the section of Promenade from Rhos Pier to the Railway Station is lighted with 34 6-ampere semi-enclosed arc lamps, run 4 in series; the Promenade from the Railway Station to Old Colwyn Viaduct is lighted with an additional 8 lamps, as previously stated, making a total of 32 lamps.

The main thoroughfares are lighted with 10 400-hour 6-ampere semi-enclosed type, 5 in series.

The district of supply is a good one, as the generating station is situated in the centre of the supply. The system is cut up into four main feeders, with feeder pillars to supply the distributors; the total length of mains and distributors is about 16½ miles.

The cables are paper-insulated, lead-covered, two layers of steel, tape, and jute served, laid direct in the ground.

The prices charged for current to private consumers is 5*d.* for lighting, and 3*d.* for power and heating. The public lighting is charged at the rate of 2*d.* per unit; the cost of maintenance is borne by the concern.

The last extensions have been carried out by the Author, at a cost of 9500*l.*

The Author wishes to draw particular attention to the financial part of the Works. A profit was made on the first year of working, which feat is very rare with Works owned by Municipal Authorities. The following tables will show the total capital expenditure and the revenue account, also the number of lamps connected since the supply was commenced:—

CAPITAL EXPENDITURE.

Year.	Total amount sanctioned.	Total amount borrowed.	Total amount repaid.	Borrowed during year.
	£	£	£	£
1901	8,584	8,584	422	8584
1902	17,034	17,034	770	8450
*1903–4	19,714	19,714	1254	2680
1905	19,714	19,714	1802	—
1906	19,714	19,714	2366	—
1907	29,134	29,134	2947	9420

REVENUE RECEIPTS.

Year.	Consumers.			Public lighting.			Meter rents.			Sundries.			Total.		
	£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.
1901	1055	8	1	300	10	10	34	18	0	56	18	9	1447	15	8
1902	1760	9	6	386	2	0	21	15	0	91	6	9	2259	13	3
*1903–4	2604	2	9	361	9	6	38	18	0	122	1	2	3126	11	5
1905	2472	19	2	228	7	8	38	17	0	150	18	3	2891	2	1
1906	2706	5	2	344	15	0	44	1	0	126	1	4	3221	2	6
1907	3129	10	5	407	6	2	48	15	0	206	11	10	3792	3	5

REVENUE EXPENDITURE.

Year.	Generation.			Distribution.			Public lamps.			Management, rents, and taxes.			Total expenditure.		
	£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.
1901	659	7	1	10	19	4	51	14	9	164	0	1	886	1	3
1902	759	10	8	12	13	9	76	11	9	321	7	9	1170	3	11
*1903–4	1049	0	11	23	13	11	80	15	10	429	1	8	1582	12	4
1905	1065	3	2	40	13	5	114	3	6	387	7	9	1607	7	10
1906	892	12	7	28	4	4	93	2	4	462	14	5	1476	13	8
1907	1065	1	2	9	7	7	162	6	8	564	16	10	1801	12	3

* Fifteen months.

Year.	Generation and distribution.	Interest and principal.	Total.	Total receipts.	Nett profit.
	£ s. d.	£. s d.	£ s. d.	£ s. d.	£ s. d.
1901	886 1 3	542 12 9	1428 14 0	1447 15 8	19 1 8
1902	1170 3 11	770 19 3	1941 3 2	2259 13 3	318 10 1
*1903-4	1582 12 4	1079 9 5	2662 1 9	3126 11 5	464 9 8 (less £1 15s. 9d. bad debts)
1905	1607 7 10	1205 0 2	2812 8 0	2891 2 1	78 14 1 (less £18 10s. 11d. bad debts)
1906	1476 13 8	1292 1 10	2768 15 6	3221 2 6	452 7 0 (less £5 10s. 3d. bad debts)
1907	1801 12 3	1199 3 5	3000 15 8	3792 3 5	791 7 9 (less £22 11s. 11d. bad debts)

Lamps connected (8 c.p. lamps)—

Year.	Lamps.
1901	6,085
1902	9,750
*1903-4	13,644
1905	15,208
1906	16,600
1907	18,000

Units generated—

Year.	Units.
1901	65,233
1902	116,106
*1903-4	179,386
1905	175,836
1906	212,154
1907	211,233

DISCUSSION.

MR. J. S. BRODIE: I should like to propose a vote of thanks to the Authors of the papers. In regard to Mr. Jones' paper, I wish to say first, in regard to the limestone roads, that there will be very ample opportunity for him to experiment with palliatives in the way of laying dust. I think Mr. Jones has hit the nail on the head with regard to this question of dust when he says, " the only remedy for the dust complaints (in his

* Fifteen months.

opinion) is the adoption of tar macadam for all macadamised carriageways." I arrived at that conclusion a good many years ago, and my policy in Blackpool during the past six or seven years has been to steadily eliminate macadam roads, and, if possible, have nothing but impervious roadways. The different solutions, as their names suggest, are only temporary and evanescent in their effect. At Blackpool, the practice for some years has been to have only three classes of roads—wood paved, tar macadam, and for the back streets Haslingden stone setts. I wish to congratulate Mr. Jones on his very excellent sea-wall. I, like Mr. Jones, have been fighting Father Neptune for many years, sometimes with more, sometimes with less, success. Mr. Jones has put a very good strong backing to the limestone face of his wall. I think he says he has put in a concrete backing as strong as 6 to 1. I suggest that is rather overdoing it; he might have been content with a little less than that. The backing of the wall at Blackpool is 10 to 1, including "plums" in the matrix. We have put 10-ton "plums" in the wall, which reduced the cost very materially. I notice how smooth the limestone facing is wearing under the action of the sea. We know that limestone is not sufficient to withstand the erosive action of the sea. That is why we at Blackpool used basalt from the Rhine district in Germany. The public should be grateful to the Colwyn Bay Council for the trees they have provided for them. With regard to the infectious diseases hospital I would like to know what the cost per bed has been.

As to private street work. In my district we have required the streets to be made up of Haslingden stone setts six inches deep grouted with asphalt, so as to make them impervious. That is an expensive matter for property owners. I have laid, experimentally, some tar macadam private streets, which being less costly, will be a great relief to large owners, who are hardly hit by having to pay for the private streets formed with setts as above described. Referring to Mr. Green's paper on the sewage outfall works, there is nothing more difficult than to get rid of sewage in a town where there is sea bathing. To have people bathing on the foreshore and to tumble crude sewage in among them is a thing nobody can look upon with composure. It is a relic of barbarism, and the day will come when we in seaside places will have to purify our sewage before we turn it into the sea. Mr. Green has solved this question by

means of screens, he screens all his sewage before discharging into the sea. That is a very good device, and it has been adopted successfully in other seaside towns. It is a step in the right direction, but we shall have to go further than that in a very short time. With reference to Mr. Farrington's paper on the water supply, I notice the pipe is run some distance into the lake. I suppose that is because the lake has got what we call a "muddy verge" or something of that kind, otherwise I should like to hear why it has been laid into the lake in that way. I remember eight or nine years ago putting a 21″ main into Ennerdale lake, in Cumberland, and I had to run it 700 feet into the lake before we got clear water. I think most people have given up the practice of using earthenware pipes, and I should like to hear if there is any reason but economy for their use. The paper of Mr. Tudman is also gratifying, as showing the leaps and bounds with which the electricity supply in a small town has gone up. I see that last year the very respectable balance of £820 accrued at Colwyn Bay. If this goes on it will be a source of income, and a valuable financial asset for reducing the rates.

Mr. Oswald A. Bridges: I desire to second the vote, and should like to add my testimony to what has been said in regard to the excellent papers. As the representative of a seaside town, I can congratulate Mr. Jones on the very important works which he has carried out. With regard to the isolation hospital, I wish to ask why Mr. Jones has been obliged to surround it by a wall or fence 6′ 6″ in height. I also desire to know the make of the disinfector used. I should like to have a little information with regard to the tides off the coast of Colwyn Bay. I take it they flow east and west. I also wish to know the time of discharge, whether on the half ebb, three hours after high water. I hope we shall never have to treat the sewage of seaside towns in the way suggested by Mr. Brodie; if so, it will be a serious matter.

Mr. J. T. Eayrs: Our thanks are due to the Authors of these papers for the excellent matter they have placed before us. I notice that the reservoir described by Mr. Jones is uncovered. May I ask how long this has been in use, and whether the water vegetates at all? I would also like to know whether the groynes he has put down on the foreshore, either at right angles to or at an angle with the shore, are quite effective for the

purposes for which they are intended, and whether there has been any substantial accretion of shingle as a result of placing them there. With regard to Mr. Green's paper he has certainly taken a great deal of trouble in giving us all the detailed information he has. I am particularly interested in the set of the tides here, and I would like to see the diagrams of the tidal survey. This is a point one has to determine before arranging the position of the outfall sewer. There are many places where the outfall sewer might discharge in front of the town without danger, but it all depends upon the set of the tides where the outfall shall be fixed. I know places both on the East and West Coast where one can see sewage coming right on the shore and in one case where I was engaged, an expert came to give evidence from a seaside resort—a popular place—and he admitted that at certain times the visitors bathed in the sewage. I may say that was only under pressure from counsel in cross-examination. I would like to ask Mr. Green, with reference to the statement that the sea outfall is 1530′ below low-water mark of ordinary tides, whether he means spring or mean tide? Mr. Green also says: "The overflow pipe in the manhole at Church-road is connected to the sea outfall; it therefore cannot come into action at the time when the reservoir is discharging." As the overflow weir is only 1·50′ above O.D., I would like to know what happens when rain falls between full and half tide. The tide rises to 14′ above O.D., and I should imagine that the sewer is absolutely locked and no flow can take place. I would like to ask whether the penstock valves to which Mr. Green refers are kept shut down or always open, or do they have to be operated when rain falls. If so, the man is probably not there to open or close them when the rain does come. On the same page of the paper there is a description of the screens for screening the sewage. With regard to these screens, I do not know whether Mr. Green has had any experience of their working. They have never been in use in other places when I have seen them, and I am told they are of no use whatever. I notice they are worked by machinery, and perhaps Mr. Green can give us some idea of the cost of revolving these screens, and also the power used—I mean the total power for working the screens and the spraying to prevent them getting clogged up. My own idea is that a revolving screen is nothing like so good as a fixed screen with rakers. I wish to congratulate the

Engineer and the Council on the excellent arrangement made with the contractors for the supply of machinery. From my own experience of these engines, I should say that the Colwyn Bay Council may be prepared to pay the 1 per cent. My experience of the duty of engines of this particular make has been most satisfactory, and they have always come out better than the official test. The calorific value of the Colwyn Bay gas is very good. I have had some experience of the quality of gas, and 620 B. Th. U. per cubic foot is very good indeed. I should like to ask Mr. Green what arrangement he has at the end of the outfall sewer for the final discharge. I congratulate the Colwyn Bay Council on having had the courage to settle the question of the compensation to be paid to owners of property. The case was decided recently in which, I have no doubt, the claimant felt in good faith he was entitled to compensation for the erection of a pumping station near his property. On the other hand, the Colwyn Bay Council and their advisers evidently thought he was not entitled to such compensation. I am glad it has been settled, because, although Colwyn Bay has spent something in law costs to get the question decided, it will save other towns. It does not matter to us whether the verdict was for the Council or against it; the great thing is that a principle is decided; and we now know where we are.

MR. J. LOBLEY: I have very great pleasure in supporting the vote of thanks to Mr. Jones and the other gentlemen who have contributed papers. I agree that the time is not very far distant when even seaside places will be required to clarify their sewage so that there will be nothing observable in the effluent when placed in a glass. They could without any great cost clarify the sewage; as they would not have to make it fit for drinking. Mr. Jones, in the course of his paper, alludes to the Private Streets Works Act of 1892, and compares it with section 150 of the Public Health Act of 1875. Mr. Jones says he has had a good deal of experience of both Acts, and I should like him to give us a paper some day and tell us something of the good things in the Act of 1892. I have never been able to discover them, and I do not think I shall advocate adoption of that Act. I have seen the effect of the operation of the Act in a neighbouring town. In one case in which I was called in the provisional apportionment was made out, and some of the owners appealed to the stipendiary

against the work being carried out, as they objected to the paving. The street happened to be very narrow, 24 feet wide, very steep—1 in 9—and the surveyor very properly said it must be paved, and that macadam was out of the question altogether. The stipendiary took a different view, and said "there is no necessity to pave it; the town must be content with macadam. The Local Authority thereupon dropped the matter, and did not do anything. That was the result of the adoption of the Private Streets Works Act.

Mr. A. M. Fowler: Our friend Mr. Lobley is rather setting up as an alarmist when he says that certain seaside towns should treat and clarify their sewage. We have the authority of the late Dr. Lethaby, whose evidence before the Royal Commission is recorded in many standard works, that sewage when diluted with ten times its bulk in a running stream after going two or three miles ceases to be a nuisance. As compared with an estuary there can be no possible objection to the discharge of sewage into the open sea, and particularly as it is here discharged well below low water mark, where the rise and fall of the tide will result in its being carried clear away. I have carried out several schemes where I have discharged the sewage into the estuary of rivers and the Local Government Board never objected; they will always allow you to discharge sewage into such outlets.

Mr. C. Brownridge: May I say, on this question of treatment of the sewage of seaside towns, I think if the sewage is screened and the rough matter taken away we need not be alarmed at the general effect. We find that in the sea, where there is a good scour and a good tide flowing, the influence of the sewage quickly dies away. It is all a question of volume. When you have sewage going into a narrow stream, where the quantity of water is limited, you get an entirely different condition of things from what you have to deal with when there is an unlimited expanse of sea. I congratulate the Authors of the several papers, and have pleasure in supporting the vote of thanks that has been proposed. Mr. Jones has kindly promised some further information as to dust-laying compounds. We, in Birkenhead, have used a great number of compounds. We find that the makers have a very high opinion of their compounds; but I am going to be content with my own opinion after long trial of the materials supplied. We water a

number of our streets with salt water, and the surfaces treated in that way are good although there are certain objections. It seems to me there are objections as well as advantages with all dust-laying compounds, and it is a question for independent investigation which have the least disadvantages and the greatest advantages.

I notice Mr. Jones has got the same difficulties as we have in Birkenhead as regards the frequent cutting up of the surface of the roads. It is a pity that the control of the road surface should not be entirely in the hands of the surveyor to the Local Authority—whether the trenches are cut for electric light, gas, or water. I think the cutting of the surface and the reinstatement should be in the hands of the surveyor who would be responsible if the result was not satisfactory. I would also congratulate the District Council that Mr. Jones has persuaded them to agree to the hydraulic testing of pipes. That is a small matter, but it has a tremendous effect upon the health of the people who are living and visiting here.

MR. J. PRICE EVANS: The Isolation Hospital is a most excellent building, splendidly situate, but at the same time I think when we choose a site for a hospital of this kind we should find a place the surroundings of which would be as cheerful as possible for the patients. Unfortunately for the Isolation Hospital at Colwyn Bay, you have on one side a cemetery and on the other a monumental mason's yard.

There is only one other matter, the cost of removal of ashes and house refuse. In seems to me you are paying rather a big price for the removal of these. The cost for scavengers is 1*s.* 0½*d.* per load, the cartage is 2*s.* 1½*d.* and the rent of tip 6¾*d.*, which makes a total cost of 3*s.* 8¾*d.* If the tip is on the outskirts of the town, and a man can manage to get eight or ten loads a day it must be a paying job.

MR. E. E. W. BERRINGTON: I should like generally to support what has been said as to seaside towns in future having to treat their sewage more effectively. I do not say it will be the case at Colwyn Bay where you have a strong current to carry away the sewage, but there are towns where they will have not only to clarify but to filter it before discharging into the sea. Mr. Green says: "Acting upon Mr. Latham's advice the council abandoned the gravitation scheme for one comprising pumping." I should like to know their reasons for doing

that. It seems a very important matter. It is stated that the level of the outfall sewer is 17 feet below Ordnance datum, and the lowest built upon land 18 feet above Ordnance datum, which is a difference of 35 feet. The casual visitor would think it possible to carry out a gravitation scheme between those two levels. I do not know the reason for abandoning that scheme, but it seems that there is a large portion of the town built on high ground, and even a partial gravitation scheme might have been a saving in the future. I should like to congratulate Mr. Green upon the specification for machinery. I think the clause in which the makers are made to guarantee the machinery after nine months' work is a very good thing indeed. I should also like to ask with regard to the pumping machinery if he took into consideration the question of adopting centrifugal pumps, as the lift is only a small one, and also his reason for adopting ram pumps. As to dust laying, I should like to hear Mr. Jones's views as to the preparation known as "Plascom" for dust laying, as I understand experiments have been made with it in Colwyn Bay.

Mr. W. Welburn: Last year I made several experiments for dust laying on my roads, with both cold and boiled tar. I first tried cold tar, which, after a fortnight on the road, was a complete failure. The cost was 1*d.* per square yard, the tar costing 5*d.* per gallon. Then I treated the roads with hot tar, boiled in a boiler on the roads. The cost of this method of treatment was 1½*d.* per square yard. Some of the lengths of road are as good to-day as when it was done, but I agree that there is only one cure, and that is sett paving.

There is one matter with regard to the sewage disposal of seaside towns. It is all very well to say you are turning out half a million gallons a day within a certain distance of the foreshore, and that the tide clears it away, but I am convinced that towns like Blackpool and Colwyn Bay will have to deal with it differently in the future than they are doing at the present time.

Mr. G. Green: Calcium chloride appears to me to answer as a palliative for dust very efficiently, so long as you have dry weather, but if any rain comes, beyond a shower, then you have mud, which is almost as bad. A road treated with calcium chloride produces more mud in a given time than a road which has not been so treated. I have come to the conclusion that

unless you can afford to have an impervious surface, such as tar-macadam, the next best thing is to paint the surface with tar. The painting with tar comes out as the same cost as calcium chloride for one year's treatment, but it also has the advantage of preventing the road deteriorating in wet weather. I have some main roads in which the tar remains until autumn or early winter, and that, in itself, is a great economy. In roads with little traffic it lasts over the winter.

MR. H. RICHARDSON: With reference to the treatment of the roads with calcium chloride for dust laying, I notice this commodity is now 30*s.* a ton. A few years ago, when I was conducting some experiments on the roads at Handsworth, I used a waste material from the salt works, which cost 7*s.* per ton in Birmingham. I must congratulate Mr. Jones and Colwyn Bay on the fact that Colwyn Bay is a seaside resort where trees can be got to grow. The fact that trees grow so luxuriantly in Colwyn Bay proves the excellence of the climate. Mr. Jones says: "In one street the service tree has been planted, and with its flowers and berry is much admired, but with the introduction of tar pavements this, as well as some of the others, appears to be affected, and does not thrive as it did before this paving was laid." I would like to know whether Mr. Jones thinks this is due to the impervious nature of the pavement or to the gases from the tar in the pavement. I have never noticed anything of the sort in my district. I notice that the street lighting by arc lamps costs something like £7 per lamp, which seems extremely low. I should like to know if this is the total cost per lamp, and, if so, what sort of arc lamps they are. I feel sure it will not be long before a place like Colwyn Bay will adopt a destructor for disposing of its refuse; in fact, it cannot afford to do without it. When one looks at the heavy cost of the present system of disposal of house refuse in Colwyn Bay, one cannot understand how the place has gone on so long with it. As to Mr. Green's paper, the cost of the sewage disposal works is stated at £62,000. Mr. Green has not given us the cost of the intercepting sewer, the sea outfall, or the storage reservoir separately. I would be glad if the figures can be given in more detail.

The vote of thanks was unanimously passed.

MR. W. JONES, in reply, said: I wish to thank you all for the vote of thanks which you have passed to me.

I found it was imperative to have the concrete backing of the promenade sea wall made as strong as possible, in order to resist the extraordinary strain exerted on the wall by the action of the sea.

The cost of the Isolation Hospital I find works out, at just over 300*l.* per bed.

I am sorry to say that the Local Government Board insisted upon our making the walls round the Infectious Diseases Hospital 6′ 6″ high.

Mr. Eayrs has asked a question as to the open high level reservoir. I have already said the sides and bottom are of concrete, but time alone will show whether the water will be affected by vegetation, and if it does my only remedy will be to cover it.

With reference to the question asked as to groynes, I may say that those laid at right angles to the face of the sea wall answer the best, and within the last 4 or 5 weeks I have been able to collect 5′ to 6′ of shingle against the face of the sea wall, while those which have been fixed at an angle to the face of the wall do not appear to answer their purpose at all, and I fear that I shall be compelled to take them up.

As to the use of "Plascom," as a dust preventative, I think there is a great future for this material. In its use for road-work I find we do not have to use any binding for the road metal at all; we simply consolidate the macadam by steam rolling, and the interstices are filled up with "Plascom," bringing the whole into an even surface. It does not wear into dust as ordinary binding does, and it becomes very hard, wearing evenly with the metal surface.

With reference to my experience with the use of calcium chloride I am glad to say that I have not had any experience of the mud which occurs in wet weather as mentioned by one of the speakers, and it is my firm opinion that this is one of the most effective palliatives which has been introduced up to the present date.

Mr. Robert Green, in reply, said: First of all I thank you for your hearty vote of thanks for my paper. I hope the rate-payers of Colwyn Bay will derive permanent benefit from their enterprise and expenditure upon these works. I will refer first of all to what I consider the most important part of the discussion—that is as to the necesssity or otherwise of treating the

sewage before discharging it into the sea. I am quite certain that in a place like Colwyn Bay, with a residential population, with no manufactories and purely domestic sewage to deal with, that it is not necessary to treat it before discharging it into the sea. Sea water itself is a most important factor in dealing with sewage. Sea water contains 2 cubic inches of oxygen in each gallon which burns up its own weight of sewage matter. There are magnesium salts as well as in sea water, which further deodorise and precipitate sewage matter. Owing to the rapidity with which the sewage travels to the pump well and the short period of time during which it is stored in the reservoir there is never sufficient time for it to stagnate or to become in any way offensive and inasmuch as it is conveyed into the sea at a point 2060′ from the sea wall through the sea outfall pipe in which it travels at an average rate of over 4½ miles per hour into a volume of sea water never less than 17′ in depth, sometimes 31′ (at spring tides) and on an average 22′, into a current flowing away from the Bay in a westerly direction at a velocity of from 1¼ to 2½ miles per hour, it can never return to the beach; besides which it has been proved beyond doubt that when sewage is discharged into deep sea water, such as is the case here at Colwyn Bay, there is no trace of screened sewage matter after it has been travelling in the sea a distance of 700 yds. as the mixing action of sea water is such a potent factor in disposing of sewage matter.

The intercepting sewer being nearly three miles in length, the solids are broken up in the passage of the sewage to the pump well but even if any ordinary solid matter passed into the pump well it would be effectually broken up during its passage through the pumps and its journey of 3779′ through the sea outfall sewer from the reservoir to its outlet. The theoretical time taken to empty the reservoir under the worst conditions when the engines are pumping to their utmost capacity and when the level of high water is at the highest point—at spring tides—is about 1 hour 53 minutes, without allowing for the extra time to overcome friction in flowing round the bends and the retarding influence of such curves, and about 45 minutes under the best conditions; therefore as the sewage is commenced to be discharged from the reservoir at high water and continues to be discharged to half ebb, it will have travelled a great distance in the sea before the reservoir valve

is again closed. In the first place, it has travelled a distance of nearly 3 miles, in the second place it is still travelling another 3 hours before the turn of the tide. As noted in my paper the sewage is discharged at a point 2060′ from the face of the sea wall, and 1530′ below low-water mark of ordinary tides. I think these are the principal points which ought to disabuse the minds of any one that it is at all necessary to treat the sewage before discharging it into the sea, therefore if there are any in this room who have in any way been at all perturbed by the remarks upon this matter I can assure them that there is not the slightest necessity in the case of Colwyn Bay to treat the sewage before discharging it into the sea.

In reply to Mr. Eayrs' query, the "ordinary tides" referred to in my paper represent mean tides, being those halfway between spring and neap tides; generally speaking the lines of "ordinary tides" marked upon the published Ordnance Maps are those surveyed at the fourth tide before new and full moon. Mr. Bridges refers to the currents. My assistants and I were engaged for five months in taking levels and testing the currents in the Bay and at Rhos. I have a plan with me showing the results of those observations so far as relates to the currents we traced at high tide and three hours afterwards, which he is welcome to inspect. With regard to the overflows, Mr. Eayrs refers to the fact that when the level of the sea is more than 1·5′ above O.D. the overflow fixed at that level will not act. That is so, and was deliberately arranged so, but the machinery is more than sufficient to pump the greatest quantity of sewage that can flow down the intercepting sewer which has a discharging capacity of 1217 cubic feet per minute, the pumps being capable of lifting at a rate of 1240 cubic feet per minute. The penstock valves controlling the overflows must be very carefully watched; they should be kept closed during the time the overflows are not expected to act. When heavy rain falls and the sewer attendant finds that diluted sewage is coming down at such a rate that it is unnecessary to pump it, it will be his duty to take advantage of the storm overflows by opening the penstock valves. Unless the tidal flap valves (one of which is fixed on the sea side of each penstock valve) are absolutely closed the sea water will flow up through the orifices into the sewer with a result that the engines will be pumping sea water as well as sewage, which I need hardly say will be the fault of

the attendant and not of the scheme. Mr. Eayrs inferred that the type of screen which I have adopted will not act. In this case he will find that with proper attention they will do so. With regard to the cost of working the screen, this is a matter which can easily be calculated. I am not quite sure what will be paid for the gas used at the pumping station, but the amount required to work the screen is at the rate of 60 cubic feet per hour. The power required to work the screen is three B.H.P. With regard to the guarantee in connection with the machinery referred to in my paper, if the Council have to pay the bonus instead of inflicting the penalty it will be a good investment for them to do so. The end of the outfall pipe is open. In reply to Mr. Berrington, I carefully went into the question of whether it was wise to have two methods of dealing with the sewage proper (some by gravitation and some by power), but found it was undesirable to do so. Of course it must not be overlooked that the water in the surface water sewers flows by gravitation, and that amongst the advantages of a pumping scheme are that it prevents the sewers from becoming tide locked, it ensures a continuous flow of sewage in the intercepting sewer towards the pump well and renders stagnation of the sewer impossible as happens in the case of a gravitation scheme. I made investigations and calculations to determine whether it would be better to use ram or centrifugal pumps, with a result that I found the ram pumps the more efficient, and, owing to the intermittent flow of sewage to be pumped, the more suitable. In reply to Mr. Richardson, the cost of the works is made up of the following items (in round figures):—

	£	s.	d.
Intercepting sewer	22,000	0	0
Internal sewers	4,000	0	0
Surface water sewers	4,500	0	0
30″ dia. sea outfall	12,000	0	0
Pumping station buildings and pump well ..	6,500	0	0
Machinery	8,000	0	0
Laying out land, boundary walls, entrance gates, etc.	850	0	0
Reservoir (which works out at the rate of 7*l.* per 1000 gallons)	3,500	0	0
Superintendent's residence (which works out at the rate of 11*d.* per cubic foot)	650	0	0
Gross	£62,000	0	0

Mr. FARRINGTON: There are three or four questions to answer. The first was as to the long length of gangway leading out to the standposts. The lake is of peculiar formation. For about 90 yards it is formed of a hard sinter, covered with boulders, and only 2 or 3 feet of water. It was necessary to excavate the whole of that or to put in a bay cut into the embankment. On examining the cost of that, I considered the most economical thing was to put in this long gangway. As to the use of earthenware pipes, my experience has taught me that all upland waters of this class have a tendency to fur up pipes. Where my pipes were not under heavy pressure I used earthenware pipes. In the 12-inch main nodules are formed as regularly as the squares on a draught-board, in some places $\frac{3}{4}$ to $\frac{7}{8}$ of an inch, thus reducing the capacity of the pipes. We had very great difficulty in getting the material up to this place. We lost one summer owing to the ground being so boggy. There was a rainfall of 114 inches. We have no filtering—there is no necessity for it. The gathering ground is free from human habitation or cultivated ground of any description. There were only about 2 acres of peat which were excavated and removed. With a rainfall of 5 inches or 6 inches in 24 hours the water is clear as crystal. All that is necessary is to screen it through fine copper screens. With regard to the scheme to be carried out at Colwyn Bay, the site which Mr. Jones has selected for his reservoir is practically the site for which Parliamentary powers were given in 1879. We now have in contemplation the laying of another 15-inch main to bring down the water to Colwyn Bay, and at the meeting of the Joint Board yesterday they arrived at the conclusion that the sooner that is done the better. I hope they will soon proceed with it. I am exceedingly obliged to you for the kindness with which you have listened to my paper.

The Members were entertained to luncheon at the Central Hotel, Mr. Williams, Chairman of the Council, presiding.

After luncheon the President and Members proceeded in chars-à-banc to inspect the new sewage pumping station and storage reservoir at Rhos, the foreshore works, the extension of the promenade, and the various experiments made by Mr. W. Jones for dust prevention. Then followed visits to the Llysfaen and Pentregwyddel quarries of Messrs. Kneeshaw, Lupton & Co. The

Members were massed together to witness a big blast of stone, after which refreshments were served in a marquee on the lawn of Mr. Lupton's house.

On the return to Colwyn Bay the electricity works were inspected, Mr. Tudman, the electrical engineer, and Mr. Carter, his assistant, taking the visitors over the works and explaining the points of interest.

On Saturday, July 1, *the President and Members travelled by special train from Colwyn Bay to Llanberis Station. From the station the party drove to the head of Llanberis Pass, where luncheon was provided, in a marquee, by Messrs. Bruce, Peebles & Co. After luncheon the President and Members descended into the lap of the valley for the purpose of inspecting the hydro-electric installation of the North Wales Power and Traction Co., Ltd. The water of Llyn Llydaw is tapped by two* 24-*inch mains, the water supply to the turbines being sufficient to provide a steady, continuous* 3000 *h.p. for the generating of electricity. The electric current generated is distributed by* 10,000-*volt transmission cables to a circle of quarries miles apart.*

The President proposed a hearty vote of thanks to Messrs. Bruce, Peebles & Co. and to their electrical engineering manager (Mr. C. G. Aitchison) for the opportunity given to the Members to inspect the works.

SCOTTISH DISTRICT MEETING.

June 14, 1907.

Held in the City Chambers, St. Andrews.

T. NISBET, ASSOC.M.INST.C.E., GLASGOW, *in the Chair.*

PROVOST MURRAY offered the Association a cordial welcome to St. Andrews.

Mr. Nisbet expressed his regret at the absence of the President, and on behalf of the Association thanked the Provost for the very hearty welcome which he had accorded to the members.

Mr. J. Bryce was unanimously re-elected Honorary Secretary for the Scottish District.

BYE-LAWS.

MR. J. BRYCE: I have only to report on the new bye-laws that since the last meeting at Berwick-on-Tweed, we have had the question disposed of so far as the matter of framing the bye-laws is concerned. We have framed a new set, and sent them to the Burgh Officials' Association, a body which is composed chiefly of town clerks, and we look to them to give the finishing touch. There is nothing like the legal mind for paring off the excrescences that the burgh officials put on. When they are returned we shall send them to the Secretary for Scotland and the Local Government Board for approval, and I hope that long before the next meeting we will be able to say that these bye-laws have been sanctioned by the higher authorities, and can be put in force by any burgh in Scotland,

THE MUNICIPAL WORKS OF THE CITY OF ST. ANDREWS.

By WILLIAM WATSON, Burgh Surveyor.

Historical.

St. Andrews' Municipal History is to a large extent bound up with the history of its bishops and archbishops who were overlords of the burgh, and spoke of it as "Our City of St. Andrews."

St. Andrews occupied the fifth place amongst the group of burghs incorporated under David I., and its oldest extant charter was granted by David's nephew and successor, Malcolm IV. (1153–1165).

St. Andrews differed considerably from the great majority of the sister burghs, the deliberations and actions of its civic rulers being subject to the control of the bishops and archbishops of the See.

An Act of Parliament passed in 1424 which granted to the Craftsmen of the Burghs the privilege of having deacons in each craft, whose duties were to "assay and govern all work made by the workmen of his craft," did much to foster trade, and raise the social condition of the craftsmen, and these deacons of crafts continued in the full exercise of powers—until the privileges were taken away by the Reform Act of 1832—far in excess of those possessed by the magistrates of the present century.

There is no lack of interest in reviewing the gradual decline of the city to the year 1745, and a description near that date gives the following: "The city is first seen on the south from the summit of a hill, and as we descend to it the prospect varies every minute. On the south and south-west are seen the grand ruins of the castle and cathedral, which, with part of the town,

are still enclosed by a wall twenty feet high, with lofty towers in it at equal distances. When we enter the town we see on each hand the tottering remains of fine buildings with mean huts and shades adjected to them, and very naturally think on the unstability of all earthly things."

In the year 1842 a strong effort was made to restore the prosperity of St. Andrews, and the Council of that date set their minds to make the town attractive, and although slow but sure progress has been made, it nevertheless has gone on until at the present it stands high as a health resort.

The whole history of the old grey city as a seat of learning is rich in historical, antiquarian, and literary associations, and the ruins and edifices of by-gone years give a majestic testimony to the power and worth of our forefathers.

St. Andrews, the home of golf, is situated on the east coast of Fife, and the geological character of the subsoil is generally sand with occasional areas of surface clay and rock, the out-crop of which is clearly seen along the whole frontage of the beautiful bay.

The town has a gradual slope from the centre at a level of 86 O.D. down towards the sea, and the climate of the town is bracing and particularly healthy.

The health of the town is exceptionally good, the death-rate for year ending December, 1906, being 11·992 per 1000, and the average for the past ten years is 13·144 per 1000.

St. Andrews is undoubtedly a seat of education and ecclesiastical learning, and amongst its chief attractions is the University and Colleges founded in 1411, also handsome blocks of modern schools for young ladies governed by a committee of local ladies and gentlemen.

There is no particular industry other than golf-club making, which has developed greatly during the past few years.

Statistical.

The burgh is 513·73 acres in area, exclusive of 314·866 acres of golf links, and is, for municipal purposes, divided into three wards. The population (1901) was 7621, and at the present is estimated at about 8000. The rateable value is 63,100*l.*, equal to 7·88*l.* per head of the estimated population.

The rates for the current year amount to 2*s.* 6$\frac{3}{16}$*d.* in the *l.*, and a penny per 1*l.* assessment realises 262*l.*

	Estimated expenditure.	Assessment in 1*l.* Owner.	Occupier.	Total.
	£	*d.*	*s. d.*	*s. d.*
Burgh General Assessment * ...	3512	—	1 2	1 2
General Improvement Assessment	81	$\frac{5}{32}$	$\frac{5}{32}$	$\frac{5}{16}$
Public Health Assessment... ...	410	$\frac{25}{32}$	$\frac{25}{32}$	$1\frac{9}{16}$
Roads and Bridges Assessment ...	1315	$2\frac{10}{16}$	$2\frac{10}{16}$	$5\frac{4}{16}$
Water Assessment	1907	4	4	8
Sewer Assessment	263	$1\frac{1}{16}$	—	$1\frac{1}{16}$
	£7488	-/8$\frac{10}{16}$	1/9$\frac{9}{16}$	2/6$\frac{3}{16}$

Street Lighting.

The streets are lighted by 4 arc lamps and 294 gas lamps, and maintained by the Council. Gas and electricity are supplied by private companies. The cost, for electric current, including renewal of carbons and trimming to the 4–10 ampere electric lamps of 2000 c.p., being 29*l.* 3*s.* per annum, equal to 2·9*d.* per unit, burning 1206½ hours each.

The arc lamps are situated in the centre of the carriage way, and are extinguished at 10.30 p.m. each night, and thereafter 8–16 c.p. incandescent lights are automatically switched on, the cost of which, burning 2463 hours per annum, is 15*l.* 4*s.* 4*d.*

The cost of gas is 3*s.* 4*d.* per 1000 cubic feet, and throughout the town annually there is a progressive change from flat flame burners to incandescent 3 feet per hour burners.

The lighting hours per annum are as follows:—All night lamps, Nos. 97, lit at sunset and extinguished at sunrise, 3749 hours; other than night lamps, Nos. 197, lit at sunset and extinguished at 10.30 p.m. 1206 hours.

The cost of lighting per lamp, including gas, labour, mantles, and repairs, is—night lamps 2*l.* 18*s.* per annum, other than night lamps 1*l.* 14*s.* 9*d.* per annum.

The total cost of public lighting is 720*l.*

* Burgh General Assessment includes lighting, cleansing, watching, fire brigade, bathing, amenities, and Links Department.

Cleansing and Scavenging.

The roads and streets for the purpose of cleansing are divided into five districts or "beats," and one cart is allocated to each district in the forenoon, and in the afternoon two carts are only out to pick up all street sweepings. This system has been found to work very efficiently, and ensures that all house refuse and sweepings are removed daily.

The corporation owns one 4-wheel dust-waggon, capacity 2½ cubic yards, and four dust-carts; these are horsed by a contractor at a charge of £290 per annum.

With regard to the disposal of house refuse, etc., it is carted to a depôt outside the burgh boundary, where it is freed of all tins, rags, etc., and thereafter disposed of to farmers at 6*d.* per ton.

The question of disposing of the refuse, which is fast becoming unmarketable and at the same time a nuisance, due to the liability of the loose and dry nature of the rubbish and paper being easily blown with each variable wind over the adjoining district, is being considered by the corporation, who are alive to the importance of this matter and the advisability of laying down a destructor plant.

A weekly system is in operation whereby a large proportion of the loose waste-paper is collected in bags and disposed of to a firm of merchants.

The average quantity collected per annum amounts to about thirty tons, and the sum realised is 7*s.* 6*d.* per ton free on rail at the station. This price just meets the cost of labour and cartage. Although it does not appear financially to be a profitable deal, the advantages derived are great in so far that a nuisance is mitigated and the general appearance of the streets improved.

Roads and Streets.

There are sixty-one streets within the burgh, which extend to 11¾ miles, of which 3½ miles are main or statute labour roads. Other roads, lanes, 8¼.

Of the above, 11·12 miles are macadamised,
0·62 mile is paved with Whinstone blocks,
0·01 mile is paved with limmer asphalte on 6″ foundation of cement concrete.

The widest street is 102 feet, and all new streets since 1903 are not less than 40 feet in width. The paved streets consist of Whinstone Newburgh setts $3\frac{1}{2}'' \times 6\frac{1}{2}''$, laid on a prepared foundation, with a cushion 1″ thick of sharp sea-sand, and grouted with Portland cement 1 to 4, and at a cost of 6*s.* 3*d.* per square yard.

In the year 1905, $73\frac{2}{3}$ lin. yards of compressed rock asphalte $1\frac{1}{2}''$ thick, laid on a 6″ concrete foundation, was laid at a cost of 10*s.* 9*d.* per square yard.

The proportion of paved streets is low in comparison to that of ordinary macadam, but in a residential town macadam is to be preferred.

Previous to the year 1905, $6\frac{1}{3}$ miles of the macadamised roads were maintained under contract with the District Committee of the County Council at an annual cost of £670, equal to £105 15*s.* 9*d.* a mile, and the remainder of secondary roads and public walks were maintained by the Town Council. The Town Council at that date reconsidered the terms of their contract, and in a report to his council the Surveyor submitted that the control and management of the streets should be placed directly in the council's hands, with the result that the highways are now under his department.

The macadamised roads were handed over in a good state of repair by the county authorities, and the work of keeping them in a condition suitable to the now popular mode of traffic is a matter of ever-increasing responsibility.

It is oft repeated that the motor has come to stay, and, indeed, from observations, St. Andrews has its share of this traffic, and it is a matter of congratulation that the authorities are alive to this problem, and are endeavouring to maintain the roads in an efficient state for such traffic, and also adopting almost universally the tar-painting of all their streets.

Since the Author took over the maintenance of the streets, the method adopted in repairing the ordinary macadam is that the roads are commenced about the end of March.

The work is carried on until the middle of May, when, if the weather is suitable, tar-painting is at once commenced and pushed forward with all despatch.

In the coating of ordinary macadam, where a light traffic can be assured, $2\frac{1}{4}''$ machine-broken whinstone metal from Newburgh is laid down, hard-rolled, and the only binding used

is dust and chips from the stone-breaker, no earthy or loamy sand or gravel being allowed, and to this method the Author attributes the absence of the large proportion of detritus and dust incident to a road where an undue proportion of earthy substance is used as binding.

In the main thoroughfares 2½" hand-broken metal is laid with binding in the same manner, and after the whole area has been thoroughly consolidated with the steam-roller, and the moisture from watering partially dry, a sprinkling of fine chips, ¼" peas, and dust, is spread over the surface, which in course work into the interstices of the metalling and leaves a smooth surface.

During the month of April, 1906, the Author recommended his Council to try an experiment of tar-painting one of the principal streets in the city at an estimated cost of £5, and this work was readily agreed to and operations commenced therewith.

This experiment was eminently successful, and was the precursor of an extension of the method, so much so, that in the course of two months 26,000 super. yards were treated, equal to a length of 1·66 miles on a roadway 24′ wide.

The system adopted in the treatment of the surface of the roadway was as follows:—A street, preferably in good order and recently repaired, was thoroughly swept with the rotary brush of all loose dust, leaving the surface metal with almost a mosaic appearance, and thereafter cold gas boiled tar was sprinkled from a 2-gallon watering-pan, fitted with a nozzle 8" long and ⅛" openings, so as to allow the tar to flow freely on to the surface; immediately following this a gang of workmen with old bass brooms, rubbed the tar well into the road surface. After the brushing a slight coating of whin chips, not larger than ¼" peas, was spread, and the traffic allowed to resume almost immediately.

The first street coated was similarly treated in the month of August, and at present the sides of the road are in good order, although the crown has worn slightly.

During the past severe winter no sign of mud was observed in this particular street, which has a longitudinal gradient of 1 in 307, and a cross-section of 1 in 12.

The work was carried out in warm weather, and to assist the tar to spread easily a mixture of 1 in 40 of crude paraffin

oil was added. During the season, with an exposure to variable winds such as a seaside resort experiences, it was found that a greater state of comfort was enjoyed than was obtainable by street watering.

No difficulty arose with what was universally predicted, that wet tar would ruin carpets, etc.

The cost, inclusive of all labour, plant, tar, oil, chips, etc., worked out at a total of 0·84*d.* per super. yard.

During the current year it is proposed to extend this process so that nearly 4 miles of streets will be treated.

The advantages of tar painting observed during last season may be summarised briefly:—A bituminous waterproof to the surface, an easy freedom with which the surface dries after heavy rain, a minimum of detritus and dust which gradually grind off a hard substance, a marked reduction of labour to the cleansing department, and a longer life to the roadway at a comparatively small initial cost as compared with the usual method.

Under modern traffic conditions it is advantageous to renew the treatment once, at least, in three to four months, and thereafter annually.

Footpaths.

All new footpaths are formed in accordance with a specification adopted by the Council, and consist of a 6″ foundation of hand-packed stones, wedged up and blinded with sea-gravel; a 4″ coating of one part Portland cement to four parts 1½″ whin metal or gravel is laid, and finished with a coat 1″ thick, composed of equal parts of granite chips and cement floated with a steel float and rolled with an indented brass roller.

The kerbing is formed by a 2½″ deep by ¼″ thick M.I. rail, having spikes, 6″ long, turned into the concrete, and not more than 10″ apart.

The water-channels, 9″ broad by 6″ deep, are set on 2½″ whin metal, grouted with cement with a slight sand cushion, and no channel-stone to be longer than 18 inches, and finished with a single row of 4″ by 7″ setts. The cost of forming is as follows:—Cement concrete, 5*s.* per yard; kerb of iron, 2*s.* per lin. yard; channel and setts, 3*s.* 6*d.* per lin. yard.

Trees.

The planting of trees in the principal streets has been steadily advancing, and at the present there are 150 trees which were originally planted by the proprietors in the various streets.

The trees found best suited to the district are a variety of the common lime or lindey (*Tilia vulgaris*). The Council undertake the work of trimming and pruning at an average cost of 35*l*. per annum.

Bathing.

The bathing facilities provided are enjoyed by those who sojourn to the town, and at the Step Rock the natural advantages presented by the formation of the beach and reef of rocks, allowed the Corporation scope to place there what is considered one of the largest open-air swimming ponds and shelters in Scotland.

Previous to the year 1902 the Corporation provided a portable shelter for the use of bathers, who enjoyed a dip only when the tide was suitable.

The Author was instructed to prepare designs with estimate of cost of a low-water swimming pond suitable for bathers to enjoy a bathe at all conditions of the tide, and accordingly in April, 1902, a commencement was made to construct the existing pond and extensions to the bathing shelters.

The swimming pond is 300′ long by an average width of 100′, an area of nearly an acre, with a top-water level 2′ below H.W.M.O.S.T., and was constructed along the reef of rocks on the north, south, and east sides of the Step Rock. The depth of water at the shallow end is 2′, and at the deep end 8′.

The side walls of the pond are constructed in cement concrete in the proportion of 1 part by measure of Portland cement to 4 parts clean gravel or whin metal to pass through a 2″ ring. The walls are finished 2′ 6″ thick at top, and have a batter of 1 in 8 on the outside. 9″ broad steps are formed every 2′ downwards, the thickness of the north wall at the bottom being 6′.

The top of the concrete wall is plastered with a coating of cement plaster ¾″ thick, 1 to 1, and finished with a wooden float.

The inside arris of the wall has a projecting nosing of $1\frac{1}{2}''$, and underneath the nosing is placed a galvanized iron tube rail $1\frac{3}{4}''$ in diameter, with caps screwed on ends and fixed with batt bolts to the wall.

Two flap inlet valves, 12″ and 18″ diameter respectively, are fixed in the east wall for filling purposes, during low-stream tides, and an 18″ wall sluice is fixed at the deepest end for the daily emptying of the pond.

The entire cost of the scheme was 850*l.*

No charge is made for the pond, but shelters are provided, where a nominal charge of 1*d.* per bather is made, and a revenue of 95*l.* is annually collected, sufficient to meet the expenses incurred, only interest and sinking fund being charged against the General Assessment Account.

A rescue boat and attendant are daily in attendance, and it is a matter of congratulation that no drowning accident has occurred at this station.

Two years after the construction of this pond, a similar pond was designed by the Author at the Castle bathing station for the ladies.

This pond is 160′ long and 65′ broad, an area of 38 poles. The depth of water at the shallow end is 6″, and at the deep end 5′ 6″.

The construction of the walls was in cement concrete, and in all respects similar to the pond at the Step Rock. The cost of the pond was 293*l.*, and the erection of a shelter was 160*l.*

A charge of 1*d.* is made for the use of the shelter, and a revenue of 21*l.* is collected.

The bathing shelters are so designed that the entire woodwork is taken down at the end of each season.

An additional shelter is also provided on the fine stretch of sand known as the West Sands, and is also largely taken advantage of. Cost 45*l.*

Women attendants are stationed at each of the ladies' bathing shelters.

Bruce Embankment.

The work of reclaiming from the foreshore has steadily been advancing since the inception of the scheme in 1882, and at the present an extent of $4\frac{1}{2}$ acres has been reclaimed.

The extension of a heavy retaining wall was commenced in the beginning of 1904, and a concrete wall 150 lin. yards in length was constructed.

The wall is founded throughout its entire length on the rock, and has a total height of 20′ above the level of the surface of the sand. The wall is 7′ 6″ thick at the base, and is reduced in width towards the top by stepping it at the back or land face, and by a batter of 1 in 8 on the sea face, finished at 3′ 0″ thick at the level of high water mark ordinary spring tides. At this level a 3′ 0″ high parapet wall was added.

The wall is constructed in 4 parts 2½″ whin metal, one part sand and one part Portland cement, and the cost amounted to 1478*l.*, equal to 9*l.* 18*s.* 0*d.* per lin. yard.

The filling in has been gradually advancing and, apart from the increase of valuable land to the community, provides an excellent rubbish heap. In the near future a further extension is contemplated, and the original scheme of laying a 12′ broad foot pavement will also be completed.

Links.

The Golf Links, which are pre-eminently regarded as without a rival in the kingdom, were purchased for the good of the community under the St. Andrews Links Act, 1894, at a cost of 10,000*l.*

The old historic course over which the amateur and open championships are played, and the New Course, which is also of exceptional sporting merit, are vested in a Green Committee, consisting of five members of the Royal and Ancient Golf Club and two members of the Town Council.

There is also the third or Jubilee Course and putting green for children, maintained and kept in repair by the Town Council, at an annual cost of 126*l.*

Water Supply.

The inhabitants previous to 1782 were dependent for their water supply from shallow wells, and in that year a tank was built at the Grange 158·00 O.D., where a limited supply was had to meet the wants of the public.

This system, which is still in operation, was augmented in

the year 1867 by the Water Commissioners taking a supply from one of the streams, about 2 miles from the City, and there constructing a small reservoir of a capacity of 180,000 gallons or thereby. This supply kept the town going from hand to mouth until 1884, until with an increasing store of complaints as to quality and quantity an effort was strenuously made to introduce the now "famous" Lochty scheme.

The Author repeats that it gained great notoriety, because in the same year that the Council approved of the introduction of this scheme, fixed contracts, and saw the work of construction well advanced, fateful November brought a sweeping majority returned to oppose the further carrying out of the work. This they effectually carried out, and instructions were given to stop the work therewith, in direct opposition to the advice of their engineer of that date, and a resolution was carried to improve the then existing works.

The total cost of abandoning these works was 11,800*l.*, which to this day stands a blot on the page of the municipal progress of the town.

Another engineer was called in to report on the extension of the existing system, and, after deliberations, Cairnsmill Reservoir, near the site of the original pond, with a capacity of $3\frac{3}{4}$ millions and situate at 187·00 O.D., was carried out, also an extension to the filters at Pipeland, situate at 149·00 O.D., and a mile to the south of the town, at a cost of 7000*l.*

These filters are still in use, and have an area of 3980 square feet, and capable of filtering 200,000 gallons per 24 hours.

Again, in 1898, the Council found it necessary, owing to the extensive introductions of sanitary appliances into the houses, to further augment the storage, with the result that the Balrymouth Reservoir was constructed as a further partial increase to the storage.

This reservoir was placed in the upper reaches of the stream, which formed a feeder to the Cairnsmill Reservoir, and only added storage capacity of 14 million gallons to the supply.

This reservoir is situate at 335·00 O.D., and has a maximum depth of 40′ at the embankment end.

There were also added four new filters and clear water well placed 60′ above the then existing filters at Pipeland.

These filters have a total area of 4000 square feet, and are capable of filtering 200,000 gallons per day. The clear-water

well has a capacity of 153,750 gallons, and is entirely built of cement concrete walls plastered with a ¾″ coat of 1 to 1 cement finished smooth.

The roof, which is flat, is constructed with steel girders 5′ 1½″ apart, and filled in with cement concrete, and covered with a soiling 1′ deep.

The media in the filters is as follows:—

Fine sand	1′ 9″
Coarse sand	4″
Whinstone chippings (¼″ to ½″)	2″
Gravel, ½″ peas to 1½″	6″
Whinstone (1″ not more than 2″)	1′ 6″
Total ...	4′ 3″

With regard to the cleaning of the filters, each filter is cleaned in rotation once a month, and at no time is the top sand allowed to be less than 1′ 3″ in thickness; with each succeeding cleaning a thin film of sand about ¾″ is removed, and no clean sand is put on until the media has fallen to its minimum thickness of 15″. The top sand used is sea sand collected on the foreshore at high-water mark, and allowed to lie exposed to the action of the weather for at least six months before use.

There is no washing of sand, as the Author finds he has a ready demand for the dirty sand from the farmers, and the expense of carting amounts to 8*l.* 10*s.* per annum.

The water from the higher filters has a connection to the clear-water wells at Lower Pipeland at an elevation of 149·00 O.D., which forms the initial head of the town mains.

There are three C.I. delivery mains to the town, 10″, 6″, and 4½″ in diameter, and so connected that each main can be used independently or collectively as occasion arises.

In the month of October, 1905, five years after the completion of the Balrymouth reservoir, the Author was instructed to report on the existing works, and to consider the question of an additional supply from other sources.

In dealing with this matter the Author, after an exhaustive survey of the district, recommended to his council the adoption of the construction of a reservoir capacity 30 millions and relative works, and situate at 362·50 O.D., at a cost of 21,000*l.*

The Corporation thereafter remitted the reports of the

Author and former engineers to Messrs. G. H. Hill & Sons, consulting engineers, Manchester, who, in the course of an exhaustive examination, advised the Town Council to (1) consider the desirability of fully investigating a proposed new site for a reservoir at Lumbo Deu, to have a proposed storage of 45 million gallons; this reservoir to be constructed on the existing drainage area, where no compensation to the stream exists; and (2) that a supply of water from Dundee was the most advantageous of all the schemes submitted to them.

The result of this report opened up fresh ground for the consideration of the Corporation, and they resolved to remit the subject further to Messrs. Bruce and Proudfoot, civil engineers, to prepare a summary of all the respective schemes, with estimate of cost, that had from time to time been prepared on this subject, with the view of allowing the Council to seriously tackle what can now only be described as an exceedingly "vexed" subject; and one would at the present hesitate before saying what scheme will be adopted.

With the increased pressure from the new works, it was found that many of the distributing mains throughout the city were found defective in size, and the Author was authorised to carry out the laying down of the following new mains in three of the principal streets, viz.—

1,550	lin. yards	8″	main
833	" "	7″	"
1,100	" "	6″	"

and the cost, including lifting old pipes, renewing services, and connecting cross streets, was £2607.

The laying of the mains calls for no special mention. Hatch-boxes were introduced at the extreme ends, and fire hydrants placed at 210′ apart. All sluice valves at intersecting streets were placed in a line with the building line of the houses.

The daily average consumption for the past five years to a population estimated at 8000 has been—

1902	309,700
1903	337,000
1904	402,500 *
1905	334,300
1906	349,216

The water rate is 8*d.* per £ on rental.

* New water mains were laid.

DISCUSSION.

Mr. J. R. Findlay: The first point that strikes me is the very high valuation of the town. I do not think any other burgh has quite so high an assessment. In Leith it is only 6*l.* per head. A total rate of 2*s.* 6$\frac{3}{16}$*d.* seems very low indeed. I notice Mr. Watson says that tar-painting of the roads is satisfactory, and that there is no mud in the streets at all. I find in streets where there is heavy traffic that the tar works up into ridges of black mud. In streets with light traffic there is no mud. I noticed that Mr. Watson adds a quantity of crude paraffin oil to the tar. I would like to know if this has been successful. The cost of tar-painting the roads (0·84*d.* per super. yard) is very low, indeed. With reference to footpaths the cost of 5*s.* per yard seems rather high. In my own burgh this work costs 3*s.* 6*d.* per yard. Possibly there is some reason, for this. A coating of 4″ thick appears a very heavy coating for footpaths. I should think that a coating of 2½″ or 3″ would give as good results if put upon a good foundation. The tree planting which has been been carried out in St. Andrews I think a very good thing, although in the large burghs it is quite out of the question, except in the suburbs. The bathing facilities seem to be altogether unique. I hope the members will have an opportunity of seeing the outdoor bathing pools. The only other point is as to the water supply. It appears an extraordinary thing to abandon works which have cost nearly 12,000*l.* This appears to have been done at election time—of course such things happen then. I presume that this work is entirely unremunerative. If the town can afford to throw 12,000*l.* away, it is no surprise that the water rate is high—and it deserves to be high.

Mr. J. R. Wilson: Mr. Watson's price for tar-painting is exceptionally small. In England the prices come out at about 2*d.* per square yard. I think Mr. Watson is conducting his experiments on a very cheap and satisfactory basis. I think the price of 5*s.* for footpaths is a little over the mark; in my district we can get the work done from 3*s.* 9*d.* to 4*s.*, the thickness of the paving being the same. The trees are an exceptionally fine feature of St. Andrews. In regard to the

bathing facilities, too, the Corporation are to be congratulated on getting their swimming-pond made so cheaply.

Mr. P. C. Smith: I should like to ask if the cost of the footpaths includes any extra work—for instance the kerbing. In my burgh we are trying to emulate what St. Andrews are doing in the matter of bathing facilities. I can sympathise with Mr. Watson over his difficulties in water supply. I am of opinion every Corporation should be the owners of its own water supply, provided it can be got at a reasonable cost and a reasonable distance.

Mr. R. Dickinson: Mr. Watson is to be congratulated on having a Council to serve who insist upon what is done being well done. The County Council's contribution of 105*l.* 15*s.* 9*d.* a mile towards the maintenance of the main road in the burgh is a very handsome one, compared with us on the other side of the border.

The Chairman: I can confirm what has been stated about the footpaths, although the price stated is high. In Glasgow the work is done for 3*s.* 6*d.* per square yard, and some of the material used has to be brought a considerable distance. As to different engineers in St. Andrews having different views as to water schemes, I think the Council would be well advised to remain with their own engineer. As to the death rate, it is very low; but I see no reason why there should be any deaths at all in St. Andrews. I am also interested in hearing what they do with their sewage; that is a very difficult problem in all burghs. I should like to know if there is any method of treatment before discharge.

Mr. Watson: I thank you very sincerely for the manner in which you have received the paper. With regard to Mr. Findlay's remarks, the tar is gas boiled tar applied cold. We have not heated a single gallon of tar. In a residential town the traffic is of a light order. There is very little mud, where a street has been tarred twice during the summer. I think the absence of mud is to be attributed not so much to the tar as to the binding material. The addition of paraffin oil is to get the tar to flow freely. I have samples in my office which show that the tar has penetrated well into the road material. As to the concrete footpaths it looks a high price, but the cement costs 42*s.* per ton and the metal 5*s.* to 6*s.* per cube yard. We get a very good class of work, but there is not much

competition. With reference to the Lochty water scheme, the works were abandoned, and we have no revenue from the abandoned work. As to the sewage we have two outfalls one on the east and one on the west side of the town. On the west side our sewage discharge is at low-water mark, about a quarter of a mile from the bathing pond. All the solids are well broken up, and we never see any sign of sewage on the sands, which are very clean and free from anything of an offensive kind. With regard to the scheme for taking water from Dundee the cost would be 6000*l.* for carrying a 9″ steel main over the Tay Bridge and 20,000*l.* for the 9″ cast-iron main from Dundee to St. Andrews, a distance of 11 miles, making a total of 26,000*l.* The price of 105*l.* per mile for the maintenance of the main roads does look a little high, but we are now able to do it at 90*l.* per mile, taking an average street of 24′ wide.

CONSTRUCTION AND MAINTENANCE OF ROADS.

BY THOMAS AITKEN, M.INST.C.E.,
COUNTY SURVEYOR, CUPAR.

ONE of the most pressing questions at the present time is the change which it is absolutely necessary to adopt in the making of macadamised roads in order to suit the altered conditions of the traffic passing over them. The advent of steam rolling and the application of the best wear-resisting materials in repairing roads were an advance on previous methods of incalculable benefit to all users of the highways. In recent years a more extended use of the roads has been made in this country; and the employment of traction engines with waggons and heavy motor vehicles for conveying produce and merchandise, and also the greater use of fast-travelling motor-cars, demand that some means be adopted for protecting and improving the road surfaces, thus making them more resistant against the greater amount of wear created by the increasing new form of traffic. There can be no doubt that in a great many instances formerly inferior road materials, procured from local sources, were used, which gave bad results and were generally pronounced in mud and dust-producing proclivities.

By using such materials for repairing roads, it is not to be wondered at that the increasing and the new forms of traffic have made demands on those responsible for road management for improved conditions. Even in districts where the necessity of employing the best materials obtainable and of practising approved methods of construction were not only anticipated, but actually carried out in view of such altered conditions becoming general, the results have been entirely satisfactory—nevertheless, further improvement is necessary. It is evident, however, that notwithstanding the application of the most

suitable road stones and the employment of a binding, varying from loamy sand to the more clayey description of material, the finished road, under abnormal weather conditions, suffers considerably, owing to the cohesive or cementitious qualities of the added material being non-efficient. Even in a normal state, under the altered and varying conditions of traffic, ordinary binding material is not as satisfactory as could be desired, and, sooner or later, the internal abrasion of the road stone coating takes place, destroying the angles of the metal. The normal conditions under which the wear of a macadamised road presented itself formerly, in regard to traffic, were such that the disturbing element generally did not exist to the same extent compared with the conditions which obtain at the present time. The altered circumstances, therefore, must be studied from the point of view that the surface of macadamised roads must be made to withstand the weights now permitted upon them, and the effects produced by high-speed motor-cars under varying climatic conditions. Tar-macadam has been laid as a pavement in many streets in Nottingham for as long as 40 years, but the cost would appear to make its application to county roads on a large scale prohibitive.

Many proposals have been made, while road engineers have for many years past been endeavouring by various methods to achieve the end in view, a matter of paramount importance. The most successful system is the method of tarring furnace slag know as tarmac. The process of preparing this road material, as in most cases of tar-macadam, is to thoroughly dry the stones by heating and then applying hot tar and mixing thoroughly. Limestone has hitherto been extensively used and selected for tar-macadam, presumably on account of its absorbent properties, while recently dense blast-furnace slag of the best quality—a harder and comparatively better wearing material for similar reasons—has been adopted. Limestones are more or less absorbent, and the oil in tar may find its way into the pores of the stone, but it is doubtful if the tough binding properties of tar penetrate either limestone or slag unless they are of a soft or spongy nature, and these conditions are inconsistent with good wearing qualities. In the same manner igneous rocks, especially dolomites, the constituent minerals of which are decomposed, absorb the naphtha contained in tar. In road materials of a close-grained texture little or no penetration

can possibly take place; surface adhesion can only be relied on, and those roadstones which break with a rough fracture are preferable for tar-macadamising purposes.

The heating of the stones and the subsequent labour entailed in preparing and storing the materials, although the mixing operations are now carried out by machinery, involve considerable expenditure before the treated stones can be spread on a road and consolidated by rolling. Tarmac has been extensively used in populous places, and is giving satisfactory results even on roads subjected to considerable traffic, including omnibuses and traction engines. Although the first cost of this prepared material is comparatively high, its increased durability over ordinary macadam compensates to a certain extent for this, while a road so constructed presents a hard and smooth surface, which is practically impervious. Other means of attaining this object, or tar-macadamising, may be accomplished by applying hot tar to the metalling after it has been spread on the road. This is carried out by pouring the tar from buckets, or by hand sprinkling, the object being to grout the road stones after the coating is partially rolled, and finishing the surface by spreading dust or rock chippings over it to prevent the tar adhering to the wheels of vehicles. Undoubtedly this is a step in advance in treating macadamised roads, but the inherent difficulty of this method is to obtain a uniform application, and of preventing a large quantity of tar, which is very mobile when in a hot condition, reaching the bottom of the metal coating. Such irregular applications will sooner on later affect the work, and the tar will become sticky and troublesome in hot weather, and probably bring about disintegration. The application of boiling tar on cold road stones also deserves consideration, as in many cases it will be found that the tar is chilled, which condition renders it liable to peel off the stones. A system of top-dressing macadamised roads after being consolidated in the ordinary way is practised in the Highland district of Perthshire. This is carried out after the road is dry, and consists of the small chips or screenings from the stonebreaker, previously treated with tar, being spread over the surface and rolled, and has given so far fairly good results. These methods of treating macadamised roads with tar have been practised for years past in Canada and Australia, and also in the U.S.A.

The great difficulty hitherto experienced has been the

application of the tar. Being of a viscous nature, it is impossible to use it in a cold state with ordinary appliances. A heating apparatus is, therefore, necessary for its application, either when treating the road stones for subsequent use or for *in situ* work. This necessarily involves considerable expenditure, and augments the cost per ton of metal applied. It is absolutely necessary that the tar should be matured or refined before using, as the light oils and ammoniacal liquor are deleterious elements. It is also essential that the tar should contain a sufficient amount of binding or viscous ingredients which otherwise would be deficient in toughness. Tar varies very much in quality at different gasworks where it is produced, and even to a great extent at the same works. Good and poor qualities of tar are, apparently, quite common, and chemical analysis, so far, has not been able to differentiate between them. Undoubtedly, very good results have been obtained on many tar-macadam roads, while work of a similar nature has sometimes proved far from successful. The nature of the road stone may, to a certain extent, account for this, but it is the general experience that the quality of the tar demands careful consideration. Certain varieties of rock used as road stones, although very successful under ordinary circumstances, do not, from their mineralogical aggregation, satisfy the conditions for tar-macadamising. Road stones, especially of the dolomite variety of rocks, which possess a rough fracture, and which have been more or less discarded in favour of better wear-resisting material, are, owing to this peculiarity, better adapted to retain the tar coating. These descriptions of road stones bind better and form a homogeneous mass, and, therefore, eliminate internal wear of the metal coating. On the other hand, road stones composed of large crystals of quartz cannot reasonably be expected to prove successful materials when treated with tar.

The application of tar to macadamised roads has occupied the Author's attention for many years, and various methods of applying it have been tried with, generally speaking, beneficial results, but in a manner and at a cost which would not warrant its general introduction. Further consideration of the matter showed that if tar could be applied in the form of a fine spray in recoating operations, the object aimed at would be attained. By such means the ordinary method of applying water and some form of earthy binding material would be dispensed with,

and a practically waterproof road formed, which would reduce mud and dust to a minimum. The results of these experiments, favourable in most particulars, led the Author to devise an apparatus for spraying tar, either in a hot or cold state, into the newly spread coating, and so act as a matrix or binder instead of using water and a binding material. This apparatus has been in operation for some considerable time, and satisfies the necessary requirements.

In operating this apparatus it is necessary, in the first place, to pump air into the receiver to a pressure of from 100 lb. to 150 lb. per square inch, depending on the viscosity of the tar, before forcing the tar into it from the tank. In order to obtain this pressure it is necessary to travel the vehicle for some time along the road, or it may be accomplished by lifting the wheels clear of the ground and attaching a driving belt to a road-roller or traction engine. Once the necessary pressure is attained it remains constant, and the machine is at all times ready for working, and when the desired pressure is registered, the valve is adjusted so as to pump in tar, or tar and air, from the tank into the receiver. When the latter is about half filled with tar, the pressure will rise to from 200 lb. to 250 lb. per square inch, when the apparatus is ready for spraying the tar. The outlet valve may be regulated to give an exceedingly fine spray, or a larger quantity may be applied by opening it to three-quarters or full cock. The supply-regulating valve must be so adjusted that the quantity of tar pumped into the receiver will equal the amount of tar being sprayed on the road. The metalling is not rolled in the first instance, as in the ordinary system of consolidating the material, the object being to cover all the surfaces of the road stone with a film of tar previous to consolidation. This is carried out by passing the spraying machine over the loose metal once in either direction, which, combined with the great pressure exerted in forcing the tar through fine spraying nipples, ensures the whole mass of stones, to a depth varying from 3 inches to 5 inches, being equally treated. The fineness of the spray secures equal distribution, and the pressure forces it well into the metal coating. After a length of from 30 to 50 yards of full width coating has been sprayed with tar, a light layer of small chips is applied to assist in filling the interstices, especially at the surface. The Author, in using 2-inch to 2¼-inch gauge road stone, finds this necessary to

make a solid and homogeneous mass. With roadstones of a smaller size—1-inch gauge for instance—the necessity of applying chips is not essential for efficient consolidation. The main point is to use as little tar as is consistent with proper binding and to apply chips, if necessary, so that the interstitial vacant spaces will be filled with as much hard material as possible. When the coat of metalling has been thoroughly rolled the spraying machine traverses the road and sprays the surface, one turn generally being sufficient. A thin coating of very fine chips and dust from a stone-breaking machine is then spread uniformly over the surface and finished by further rolling. No sweeping is necessary by this method of construction, therefore a considerable saving is effected in labour and the cost of brooms. Two or three men only, according to the conditions of the work, are required to rake into position or add more metal and apply the chips when necessary. There is seldom any necessity for applying fresh material during rolling operations to make up depressions experienced in the ordinary method of working through the old surface being softened by watering, and the displacing action caused by the brooms in sweeping over the road stones.

The amount of tar necessary to properly coat the road stones for every ton of metal applied varies according to the size of the material used and the quality of the tar, but from four to six gallons may be considered sufficient under ordinary circumstances. This quantity of tar would, therefore, with a 3½-inch coat of metal, be equal to 0·56 of a gallon per square yard of road covered. The initial cost of making roads by this system is greater than by the ordinary method. The material after consolidation, however, becomes a homogeneous mass, and internal friction or abrasion is eliminated. The prolongation of the durability of a road so made will be greater, probably doubled, compared with the ordinary method of construction, consequently ultimate economy will be promoted. The surface of a tarred road is practically waterproof, and the elimination of dust and mud, or their reduction to a minimum, would alone be sufficient to justify the general application of tarred macadam. The cost per day of carrying out the work in the manner described for consolidating 130 tons of metal each day is 13·46*d*. per ton. The additional cost was 6*d*. to 8*d*. per ton more than ordinary macadam. The hire of two horses is charged for, but

in most instances one horse only is required. The cost of spreading the road stones and chips being the same in either case, it is unnecessary to take these items into account in making a comparison. By the ordinary methods the cost is 7·63*d.* per ton, or about 6*d.* less than when tar is used. The cost of tarring and rolling a 3½-inch coat of metal is, therefore, 1·5*d.* per square yard. On a road 16 feet in width the additional cost by using tar would be 26·08*l.* per mile over the ordinary method when water is obtained free of charge. On a similar road, but using six gallons of tar per ton of metal applied instead of five gallons, the cost would be 35·16*l.* per mile more than consolidating macadam in the ordinary way. The amount of water required per ton of metal by the usual methods of consolidation is about 40 gallons, and when this has to be paid for the cost may be taken at 2*s.* 3*d.* per day. The cost of tar varies considerably in different localities, but the quality is of the greatest importance, and only the best distilled descriptions should be used. The best form of vehicle for spraying the tar is a motor van having a large tank capacity holding about 800 gallons, which would be more than sufficient for one day's work in rolling the road-stone coating.

The results of the method of construction or repairing roads described show that the road during and after the trying climatic conditions of alternating frost and thaw presents a smooth compact surface. The "licking up" of the road stones by the wheels of vehicles under such conditions on ordinary macadam is very great, and considerable damage is thereby caused. On tar-macadamised roads, however, experience shows that "licking up" does not take place under these circumstances, consequently economy is promoted by the reduced cost of maintenance. The method of flushing the tar over the surface or grouting requires from seven to nine gallons of tar for each ton of road stones applied. This quantity is, however, excessive, and it may become sticky and troublesome in hot weather, and may lead to the disintegration of the surface. It is essential that the road metal, chips, and dust should be in a thoroughly dry state, as moisture militates against good work, therefore rolling operations by this process can only be undertaken in fine weather. The finished surface is like asphalt in appearance, and, while not equal to it in actual wear, has superior properties in some respects. Tar-macadamised roads have a certain

amount of resilience, foothold is much better, and it is practically noiseless compared with asphalt pavements.

The reason why tarred macadam, carried out in a proper manner, is free from dust and mud and wears longer than ordinary macadam, is simply because the frictional resistance of the stones is increased to such an extent that internal motion and rubbing are prevented, and the tar and chips which fill the interstices of the metal coating prevent percolation of water and the evils resulting from that cause. Tar, no doubt, might be improved by the addition of a bituminous material, which would further increase the life of a road, but, of course, at additional cost. This fairly represents the possibilities of this form of construction or tar-macadamising.

DISCUSSION.

Mr. R. S. ANDERSON: I have listened with much pleasure to Mr. Aitken's paper on the important subject of roadmaking, and dust prevention. The time has now come when something must be done. About three years ago I had the opportunity of seeing what the French are doing with tar spraying and tarred matrix on their roads. We were very much impressed with the roads outside Paris. One road was seen which had been metalled and sprayed with tar two years before, and there was practically no dust from the surface of that road as the motors passed over it. Of course, the climate is different from Scotland, it being much drier, and the road authorities can be almost sure of getting dry weather for spreading the tar. The method then adopted of spraying the tar on the road was very primitive. All the dust was brushed off the surface of the road with a hand brush, and then the tar was applied in the manner described by Mr. Watson, from a watering-can, and then spread evenly with a rubber squeegee. I must say the surface of the road was very good. There seemed an unlimited supply of money in France; and no ratepayers to consult, the work being done at the cost of the Government. About the end of May I attended the dust-laying trials in the neighbourhood of Staines, near London, but unfortunately the weather was bad, and it was pretty much of a fiasco. These tar-spraying tests were carried out by the Roads Improvement Association, and

I must say that for what were considered to be important trials, the arrangements made by the Road Surveyors and others interested were very indifferent. I think Mr. Aitken deserves credit for his paper, and for the interest he has taken in this subject.

Mr. A. J. Turnbull: I think it might be of interest if members, who have made experiments in a similar direction, were to give the results of their work. At Greenock there is a very wet climate, and not the best of conditions under which to do the work. A section of road has been done by contractors, but I am not altogether satisfied. I took in hand the remaking of Union Street. I got the metal from Gourock, having it treated with the tar there. The first coating of 2½-inch metal I put on entirely dry. This was thoroughly rolled. Then I put on a second coat of 1½-inch tarred metal. This I also thoroughly rolled, and then finished the road with a topping of ⅜-inch metal well impregnated with tar. This was also thoroughly rolled and finished off with a dusting of the same metal. The total cost for 815 square yards came to about 59*l.*, or 1*s.* 5½*d.* per square yard. The cost of ordinary macadam is 1*s.* 1½*d.*, so that the whole section was done with tar-macadam, and forms an impervious surface for about 4*d.* per square yard beyond the cost of ordinary macadam. This has been laid all through the winter since the beginning of October. It is now entirely impervious, the water running off the surface to the sides of the road, and there is no dust whatever. Of course, it depends upon the cleansing department removing the horse droppings, etc., to keep it clean. I am perfectly satisfied that it is a great improvement upon ordinary macadam, that it will last much longer and keep free from dust and mud.

Mr. Bryce: Do I understand from Mr. Turnbull that he tarred this himself or got the tarred metal?

Mr. Turnbull: We got the tarred metal from Gourock. The price is 9*s.* 6*d.* per ton, tarred and carted up to the site. Our ordinary metal costs us 5*s.* 6*d.*, so this is 4*s.* extra for the tarring and preparation of the metal. The traffic over the road is ordinary medium traffic.

Mr. A. H. Goudie: I am pleased to hear Mr. Aitken's experience of the effect of frost on the tarred surface. I tried in Stirling the system of putting on tar and rolling it hard. It was a very great success until the frost, and then it became

a dead failure. When frost appeared the surface broke up. When spring came the traffic brought it back again into its place, but for some months the road was in a very bad state, and required recoating. I did not do so, but waited, with the above result. At Greenock Mr. Turnbull is in a very favourable position, as he can get the tarred material, but 9*s*. 6*d*. per ton appears quite a high price to pay for it. I do not know what it will cost to bring to Stirling or St. Andrews. I am afraid before it can be adopted, a mixing machine of our own will be required.

Mr. J. R. Findlay: In Leith we have been tarring the roads for three years. The whole of our nine miles of macadam roads are so treated. On some of the main roads it went all to pieces in the winter months, and worked up into black mud, and although it is elastic and recovers to some extent in the spring, I think it is a failure where there is heavy traffic. I do not think tar-macadam will solve the dust problem; it is too expensive, in my opinion. I read in some of the English papers of fish being killed owing to the tar running into the streams. In one place I notice that thousands of fish have been found dead. The cost of tarring in Leith is 1*d*. per yard. I notice Mr. Watson has applied his tar cold; in Leith the tar is always heated before applying it.

Mr. R. Blackwood: I have laid a roadway with tar-macadam extending to about 7000 yards this spring. We made the necessary material ourselves, rigging up a boiler, in which we boiled the tar. We used ordinary 2½-inch metal, and after treating it with the tar, put it on the road to a depth of about 3 inches, rolled it well, and covered it with a coating of ½-inch chippings, thoroughly impregnated with the tar. The cost was something like 1*s*. 1*d*. per square yard, or 2*d*. to 2½*d*. more than ordinary metalling. We managed to lay it in fairly good weather, and so far it has been quite successful. Of course, the weather has been so much against this sort of work that I have not gone further with it, but I am proposing to carry on the experiment.

The Chairman: This problem of dust prevention is one of vital importance to all road authorities, and has been the subject of much correspondence in the newspapers. The dust is a great nuisance, and the question is how to get rid of it, and it must be got rid of in some way. It will be a matter

of considerable expenditure, but the authorities will have to face this expenditure, even at an increase of the rates. In Glasgow experiments have been made with tar-macadam, the bulk of the work having been done by contractors. The results have been variable—some satisfactory, some very unsatisfactory; but in no case has tar-macadam been satisfactory where there has been a large amount of traffic. In the case of two streets where it had been laid by the contractors as an experiment at their own wish, it had not been down three months before the contractors took it up and repaid the money to the amount of 1500*l.* It was a very serious item to the contractors, but they have learned the lesson. The tramway authority have experimented with macadam grouted with tar, but it has turned out very unsatisfactory. I think we are very much indebted to Mr. Aitken for his very valuable paper, and I have pleasure in moving a vote of thanks to him.

The vote of thanks having been accorded,

Mr. Aitken, in reply: I wish to thank you for the manner in which you have received my paper. As to Mr. Anderson's remarks as to the tar painting of roads in France, I do not remember when tar painting was started there; but I have been at it for eight years. My plan is to coat the road, then spray it with the tar, and afterwards roll it so as to ensure all the metal being thoroughly impregnated with the tar. Mr. Goudie mentioned as to the effect of frost on a tarred road. I do not find it any worse than an ordinary macadam road. I think Mr. Goudie's trouble is caused by incorporating too much tar in the body of the road. The quality of the tar is also a most important thing. You can have good results and bad results from the same class of materials, but with different qualities of tar. Mr. Findlay spoke of the tar working up in the form of mud during the winter. I can understand that, if there is no penetration of the tar into the road. Wherever the tar has penetrated 2 inches I have never found any mud at all. In roads I have laid there is no dust or mud. As to killing fish, that can only happen where the tar has been flushed on to the road and it has run into the ditches. Some remarks were made as to tar-macadam not standing heavy traffic in the towns. My paper refers to country roads and not to town streets at all.

Mr. J. R. Wilson: I am of opinion that we should make

this an Imperial matter and force the hands of the Government to take it up. The ratepayers, of both town and country districts, cannot afford the money which is required to be spent on the roads to deal with the dust problem. I think we should get the head officials of the Association to take it up.

THE CHAIRMAN: I understand this is under the consideration of the Council of the Association.

The Provost and Corporation of St. Andrews entertained the Members to luncheon at the Cross Keys Hotel. Provost Murray was in the chair.

The afternoon was occupied with a visit of inspection of the new sewage disposal works for Cupar. These works have been designed by Messrs. H. Bruce & Proudfoot for the treatment of the sewage of Cupar on the bacterial system.

The Members then drove to Cupar, where they were entertained to tea by the Provost and Corporation.

In the evening the Members attending the meeting dined together at the Cross Keys Hotel, Mr. Nisbet presiding. The Provost and other Members of the Corporation were present.

ANNUAL MEETING IN LIVERPOOL.

June 20, 21, and 22, 1907.

THE PRESIDENT'S ADDRESS.

By JOHN A. BRODIE, M.Eng., Wh.Sc., M.Inst.C.E.

I desire to thank you very heartily for the honour you have done me in electing me to the honourable position of President of this important Association for the year. I assure you that I appreciate very highly this honour, coming, as it does, from the members of that branch of the civil engineering profession with which I have been connected for many years. I am sure I may rely upon that kind assistance and support which it has been the invariable practice of this Association to accord to its president, and I shall be very pleased to do all that lies in my power to advance the interests and influence of the Association, and to maintain the dignity of the presidential chair. I cordially welcome to Liverpool the Members of the Association and the representatives of the various local authorities who have been appointed to confer and to discuss with us, as an Association, matters of mutual interest.

The Association of Municipal and County Engineers, like most other similar associations, was started in a small way some thirty-four years ago, and it had for one of its primary objects the arrangement of meetings in various parts of the country, at which gentlemen, occupying the position of engineers to towns and other local authorities, could meet together from time to time to discuss the various methods of carrying out the duties appertaining to their office, with the object of obtaining the best results; and also to visit and inspect the works in progress and completed, and it has been found that these visits and discussions have been of great advantage both to authorities

carrying out works and to their engineers by enabling them to keep themselves up to date and to acquire a knowledge of the newest methods and materials for works which they, as engineering officials, may be called to advise upon or to carry out for their own authorities.

The Association has for its motto "Progress," and from time to time it has broadened its bases, and it may now be said to be fairly representative of the views of all engineers engaged in connection with towns, counties, urban and rural authorities. The Association has also been looking after the interests of public bodies and the status of the municipal engineer by instituting qualifying examinations for young municipal engineers, the papers for which are prepared by a body of properly qualified professional men holding responsible and principal engineering positions, the subjects included in these examinations embracing engineering, surveying, building construction, sanitary science, and public health law; and after completion of the written examination, the candidates are examined orally in the different subjects, passing in turn before each of the examiners, and members of local authorities may be assured that the holder of the Association's diploma has had at least a competent engineering education and practical experience in engineering work, and is, from a professional point of view, qualified to take up the responsible duties of an engineer to a local authority. To the members of the Association this is, of course, very well known, but I have thought it well to make clear what the position and objects of the Association are, more especially as to-day the Association has taken a further step in its progressive policy by inviting representatives of various authorities to join and take part in our annual meeting; and it is hoped that this interchange of views on mutual ground between representatives of local authorities and their engineers will tend to broaden and enlarge the views taken of the bearing municipal engineering works have upon the health, comfort, and convenience of the inhabitants of our various districts.

Of course, this method of education has a great many critics. It is said that such meetings and conferences, with people interested in kindred subjects, are practically "outings" at the expense of the public. It appears to be thought by some that statements to this effect are a sure method of securing notoriety,

whilst others, with no doubt good enough motives, consistently object to any expenditure out of the public funds on visits or inspections of any description. Such criticism very rarely comes from the really thoughtful section of the community, and practically never from those who are really responsible for the carrying out of important works and improvements. Those statements do a great deal of harm, as they tend to prevent the best qualified and busiest men from giving their time to public duties, and they appear to many of us who are behind the scenes particularly ungracious when applied to the chairmen and members of committees who regularly give up a large amount of their valuable time and shoulder heavy responsibilities and fight them through, often in the face of considerable opposition. Chairmen of committees, in my opinion, seldom receive a tithe of the credit due to them for their often laborious and responsible work on behalf of the public.

In my opinion visits to other towns and, where necessary, to foreign countries form an important part of the education of any gentleman responsible for the execution of public works, and I believe great good would arise from a systematic examination by deputations of municipal works carried out in other towns and countries. I have considered this policy of so much importance that, since my election to the position I now hold, it has been my consistent practice to visit during my summer vacation one or more of the great towns abroad, in order to gather anything which might be of advantage in connection with carrying out the public works of this city. It seems to me that the city of Liverpool is an appropriate centre in which to discuss the two subjects which are now occupying so prominent a place in municipal and public opinion—viz. the laying-out of towns and the requirements of improved access by means of roads, as during the past 10 years no less than 22,000 houses have been built within the limits of the present city, representing a population of, say, 120,000 persons. Liverpool as a city has also been more largely dependent for its growth upon its means of access than any other town I know of, and this is likely to be so even more in the future than in the past.

It may almost be said that Liverpool lives and breathes upon its commerce, the raw material coming inward by means of the River Mersey, passing through the town and being sent inland to the manufacturing districts, and on the return journey

the manufactured and other materials passing through the town and out again by way of the river. Liverpool started on a very small scale, the earlier plans showing a few streets in the neighbourhood of the town hall—in which this meeting is now being held—which may also be taken to-day as the business centre. The central streets were originally narrow, and though it cannot be truthfully said that they are yet too wide, it is recorded that some of them have already been widened twice, if not three times, at great expense. The boundaries have been extended from time to time and the populous districts outside the city have been absorbed. The general policy in this as in other towns in this country has, therefore, been to leave the development of building areas on the outskirts in the hands of small local authorities, and the results—particularly as regards the main lines of communication—have been, as might have been expected, the construction of roads which served for purely local traffic, but are altogether too narrow to form satisfactory outlets from a great city.

Although no needless expenditure has been incurred on street widenings and improvements, yet the outlay on bringing up most of the main thoroughfares to a width sufficient to allow for two lines of tramways has been very considerable, and during the past 10 years alone the expenditure on street widenings has amounted to about 1,250,000*l.* The necessity for, and the advantages of, providing an ample width of street whilst the land is still unbuilt upon is well shown by a comparison between the present value of land in the centre of the city and the outskirts; land alone, without including the cost of buildings, for street widenings in the neighbourhood of this town hall to-day would probably not be acquired for less than about 200*l.* per square yard, while the Corporation have lately acquired a large tract of land for cemetery purposes in an area under the control of an authority just outside the city boundary at an average cost of about 10½*d.* per superficial yard. Notwithstanding the heavy cost which has been incurred in connection with street widenings, it has been the policy for some years past to widen main lines of communication to a minimum of 60 feet, and in some recent cases this width has been exceeded. The ordinary method of arranging for street widenings under the powers of the Public Health Act, 1875, is a somewhat cumbrous one, especially in the case of towns

where a considerable number of widenings take place, and involves a large amount of unnecessary work and the holding of numerous Local Government Board inquiries. Most of these street widenings have been carried out under the powers acquired by the Improvement Act of 1867, the procedure under which has many advantages over that of the Public Health Act of 1875, as the authority has power to fix a line of building and also to purchase so much of the land as they may consider to be required for street widening purposes out of funds provided under the Act, and without reference to the Local Government Board. It has, however, in some cases where buildings exist, been necessary to proceed by way of a special Act of Parliament or by provisional order.

Owing to the expense and difficulty in arranging with owners of property fronting main roads, in the year 1902 power was obtained to set back the line of building on each side of the centre line of any new street to a distance of 40 feet; also to vary the widths of carriageways and footways, and decide upon the direction or position of any new street; and also require the rounding off or splaying to the height of the first story or full height of new buildings at the corner of two streets. These powers have made it possible to arrange with the owners of large properties about to be developed as building areas for the construction of wide streets through their property, and a considerable length of wide streets has already been constructed through unbuilt upon areas in the outskirts. It has been the policy in these cases to assist landowners by constructing streets through lands some little time in advance of the actual commencement of building operations, and the results, both to the authority and to the landowners, have been most satisfactory. In these cases the landowners have undertaken to pay for the construction of street works in compliance with the minimum requirements of the by-laws relating to new streets about to be laid out, and have, in addition, given up a strip of land 24 feet wide, making in all a width of 60 feet.

Where the owners have agreed to this policy, and to the lines of street being laid down in a direction advantageous to the public, the authority has undertaken to purchase from the landowners strips of land 24 feet wide at the average value of the estate taken as a whole, thus making the width of street 84 feet. In addition to this, an attempt has been made to purchase a

further 24 feet width of land with the object of providing for the laying of tramway lines in the centre of the thoroughfare in such a position, and in such a manner, as to enable the lines to be fenced off in lengths between cross streets, so that the average speed of the tramcar might be very much accelerated. Under the complete arrangement a street 108 feet wide between boundary walls will be provided, and the cost of such a street over and above the cost of a street of the minimum width required by the bye-laws would be apportioned approximately as follows: one-third to the landowner, one-third to the street authority, and one-third to the tramway undertaking—the landowner getting the advantage of a magnificent thoroughfare through his estate; the street authority obtaining a wide thoroughfare at—in many cases—one-tenth the cost of the widening of parallel thoroughfares already built up which would otherwise have been necessary; and the tramway authority obtaining the advantage of quick transit, and also the additional advantage of a cheapened construction, as in this case it would not be necessary to provide any expensive form of street surface between the rails.

I have sketched the arrangements made in connection with these new roads, as the underlying principles appear to me to be sound, and the procedure may be useful where greater powers cannot be obtained. I think, however, that it is very desirable that the authorities should have larger powers in connection with the laying-out of all main thoroughfares, as the negotiations have in some cases been exceedingly protracted, and it is found that the average owner or trustee of land, whilst quite prepared to give up all land required by law, is very chary of giving up any land where compulsory powers do not exist. In this direction very considerable advantage is derivable from a study of the methods adopted for the laying-out of towns in America and Germany. In many towns in the United States and Canada, the city authorities have powers to reject or disapprove of plans for any building area submitted to them if they are of opinion that in the matter of arrangement or width of streets the plans are unsatisfactory, and I am informed that the authorities do not hesitate to reject unsatisfactory plans. Another point is that the cost of constructing streets is apportionable in yearly instalments on the property fronting such streets, and, generally speaking, these instalments cover

a period of 30 years. These are two points which might with advantage be made use of in connection with the laying-out of building areas in Great Britain.

In Germany very much greater power is given town authorities, who in many cases are required to prepare and provide a building plan in advance of building operations, and power is also given to them to settle every detail in connection with such building areas, including the provision of wide streets or boulevards, playgrounds, or recreation spaces, sites for schools churches, public buildings, etc.; and, in addition, where it is found that, owing to the irregular shape of areas or other reasons, it would be an advantage to deal with an area as a whole, they are authorised to combine a number of small areas for the purpose of the building plan, and, after they have laid out the area as a whole, to apportion the land remaining for building purposes between the owners of the original properties, or if necessity arises, to expropriate the land. It would, no doubt, be difficult to obtain powers in England equal to the German powers, but it is to be hoped that some of the larger municipalities in this country will make a bold attempt to obtain control of the laying-out of building areas, as there can be no doubt that such powers should be in the hands of authorities as would enable all building areas to be so laid out as to provide necessary roads and means of communication of ample width, and also to provide ample spaces for playgrounds and sites for public buildings whilst the land is still undeveloped, and is, therefore, obtainable at a cheap rate.

Greater powers are necessary also in connection with the laying-out of those small and irregular areas commonly to be found under separate ownerships in the neighbourhood of towns in this country. At the present time local authorities have very little control over the laying-out of streets in such areas except by arrangement with the landowner, and cases often arise in which the landowners can comply with the bye-laws and yet set the authority at defiance. Some method is required by which the authority should have the power to disapprove of such plans and to prevent, under a penalty, the construction of streets otherwise than in accordance with such conditions as they may approve in the matter of direction, width, and levels of roads. In cases of small and irregular areas, failing agreement between the respective owners as to the adjustment of

boundaries, powers might well be given to the local authority to adjust boundaries, of course after hearing evidence on behalf of the parties interested.

The question of the improvement in the laying-out of areas adjoining the boundaries of an urban district is a difficult one, as in the absence of statutory powers it would be difficult to provide for the satisfactory laying-out of building areas, and for the provision of wide roads; but even if Parliament should not be inclined to grant overriding powers to the larger towns, there does not seem to be much objection as a minimum to the smaller authorities having the right to adopt for application to their districts any sections of Acts acquired by the larger authorities.

The question of the improvement of main roads is now undoubtedly receiving, and properly so, a great deal of attention, both on the part of local authorities and the public, and it is a difficult matter to say what the future requirements in the way of main roads may be, so much depending upon the possible solution of still unsolved problems. If the hopes of many experimenters in aërial navigation are realised, it may be found that the air provides an easily renewable surface and one through which the equivalent of tractive effort might possibly be very small; and if ever this time arrives, it is just possible that the selection of satisfactory materials for light traffic roads may become a matter of comparatively little importance. At present, however, we have a distinct demand for a smooth, durable, economical, and dustless surface to meet the requirements of the lighter motor traffic, and it is also not unlikely that a very much larger amount of heavy traffic will have to be provided for, as improvements in connection with machines for heavy haulage, though slow, are making distinct progress. Another possibility exists in the formation of trains, something after the style of the road train exhibited at the last Olympia Exhibition.

Taking a broad view of the question, it appears not unlikely that in the near future the roads of this country are again to become most important systems of intercommunication both for the purposes of light traffic and heavy traffic between communities, and though it may be argued that the widening of existing roads will meet all probable requirements, it appears much more likely that in many cases provision will have to be

made for straight and wide thoroughfares between populous centres. We must all admit that our roads—particularly in the neighbourhood of large towns—are capable of great improvement. Many of them were never designed or intended for through traffic purposes, and, apart from their want of directness between points, have corners, cross roads, and other details which to-day are dangerous to the ordinary users, and should be dealt with. It is to be hoped that, where improvements are necessary, a far-seeing view will be taken of the requirements, and that, wherever it is economically possible, new roads of a suitable character to meet the requirements of modern traffic will be constructed in preference to the widening and straightening of existing roads, even though the latter course may for the present appear to be the more economical method.

The increasing use of heavy vehicles for the conveyance of goods along the ordinary roads is, in many districts, causing road engineers a good deal of anxiety on account of the damage done to their road surfaces, and it appears not unlikely that the provision of satisfactory road surfaces for the conveyance of merchandise may presently form a very important portion of the duties of the municipal and county engineer. Where sufficient traffic of a heavy character is continuously passing over a line of road to pay for the construction of a steel surface, it is hardly likely that a stone surface will be found to seriously compete with it; but there still remain many roads on which the traffic will be so mixed in character that a surface in which stone is the principal ingredient will probably meet all requirements.

Some ten years ago it was very confidently stated that electric tramways, especially on the overhead system, could not possibly come into general use in this country, and could never compete with fast trains on our local railways. Time has, however, demonstrated that tramways are more than able to hold their own in certain classes of traffic, and that the introduction of cheap fares consequent on the small capital cost of construction, which, in the case of tramways, is probably not a tithe of the capital sunk in connection with parallel railways, is one of the principal elements in connection with the success of the tramway services. At the present time tramways exist in our main thoroughfares, and in some cases in this city the

steel surfaces of these tramways are conveying a tonnage in excess of the tonnage conveyed on a single track of the principal main line of railway in the country, and without any very serious interference with the ordinary users of the street surface.

When the lessons which may be learnt from a close comparison of the two systems are fully understood, and especially if a surface is provided suitable for all classes of existing vehicles, the day for the conveyance of merchandise in large quantities over public roads will probably have arrived. I may say that, as the result of my study of special requirements for traffic purposes in connection with main roads, I have for many years been of opinion that ultimately it will be necessary in special cases to grapple with the question of cheap transfer of goods on public roads, and when this problem is faced, it will, in my opinion, be solved by the construction of wide thoroughfares having a portion of the surface laid in steel, in such a form and so arranged as to provide for the passage of railway waggons, tramway vehicles, motor trains, and fast-travelling vehicles of any type. This is, of course, no new suggestion, as in this city we have in Mr. Alfred Holt a distinguished exponent of this theory, who has for many years past consistently and persistently advocated the use of a "plateway" for goods traffic between the seaboard and the manufacturing districts.

With regard to road construction and the materials used for roads, we are told by the non-technical Press that the road engineers of the present time know practically nothing about the requirements of road construction necessitated by the advent of the motor-car. As many of us are motorists of considerable experience, we could, with some truth, retort that motor-cars are in many ways quite as imperfect and as costly to maintain as the roads over which they run. We are told that roads should be constructed entirely on the lines laid down by Macadam and Telford, and it cannot be doubted that roads so constructed have fairly met the conditions for moderate traffic up to the present time. It is, however, well known that the macadam road is entirely unsuitable for roads carrying really heavy traffic, and my experience in providing and maintaining street surfaces to carry the heaviest traffic which I know to exist anywhere—viz. that along the line of docks in the city of Liverpool, where the average two-horse load on four

wheels amounts to seven to ten tons, and where a common load behind a traction engine, I am assured by traction engine users, may be taken as 35 tons, and where exceptional loads up to 100 tons on four wheels may at any time be expected—leads me to think that the satisfactory and really economical surface for even light traffic is quite as likely to be found where the surface is so arranged as to entirely prevent any rolling or grinding action or motion of any sort amongst the materials forming it as in the macadam type of construction, in which the surface materials are so arranged as to be liable to motion under any passing load.

Of course, the other conditions for success in such street construction are very important—viz.: (1) a thoroughly satisfactory foundation; (2) a proper layer of efficient bedding for the stones on which they are firmly rammed, preventing any movement or further compression; (3) the use of a hard shingle in the joints; (4) a perfectly impermeable jointing material in the nature of a plastic mixture of pitch, sand, and oil; (5) a hard, durable, and non-slippery stone for the wearing surface. Our experience with medium traffic shows that the annual cost of maintenance of a street is practically nil over a life at present extending up to 25 years, and though I cannot at present point to any form of such construction which is entirely suitable to replace the ordinary macadam road, I venture to think that time and thought expended on the improved application of those principles to meet the requirements of lighter traffic roads will ultimately result in satisfactory solutions of the problem.

In coal tar and its products we have a material which appears likely to be largely used for jointing or filling up interstices in the materials used for road construction, and though owing to its variable nature it is not generally understood, many road engineers have done very satisfactory work with it, in most cases, however, using limestone slag or other material of a comparatively porous nature. When coal tar has been applied to the hardest materials, now so generally preferred for road carrying traffic, the results have often been unsatisfactory owing, it would appear, to the absence of porosity in the stone used. When dry, hard, and non-porous stones are preferred, great attention might, I think, advantageously be paid to the preparation and blending of pitch and the coal-tar

oils. Such mixtures have long been used in preference to tar in this district for jointing the hard Carnarvonshire setts commonly used, and when some of those pavements were being pulled up after a twenty years' life, the combination of pitch, tar oil, gravel, and shingle was found to be adhering perfectly to the stone, and to be in better condition than the best mixtures obtainable from pitch and oil materials at the time being supplied under annual contracts, and some of the material was, in fact, re-used. With the help of chemical analysis a specification was prepared both for pitch and oil, and every delivery of these materials is now chemically tested, and if found not to comply strictly with the specification, is rejected. It was found that with unvarying materials a uniformly tempered pitch mixture became a comparatively simple matter. As a simple and practical test this mixture when cooled in water at 60 degrees Fahr. should stretch at least 3 feet before breaking, and the threads so formed should pull out very finely indeed. It should also, when doubled into a length of about a foot, bear hitting hard on an iron or stone surface without showing signs of cracking. Immediately before being used, an equal bulk of hot sand mixed with a small percentage of lime or cement should be stirred into the pitch and oil mixture and kept continuously stirred until applied to the joints or the macadam, as the case may be. This mixture has been used in my department for many years, has never been patented, and forms a very useful basis from which experiments in all directions with a view to improvements may usefully be made by road engineers who require an impervious grouting either for hard setts or macadam.

Another matter which is of importance to the Members of this Association at the present time is the removal or abolition of dust from macadam roads, which, though not caused by the fast and light motor traffic, is undoubtedly lifted from the roadways and becomes a great nuisance both to the ordinary user of the roadway and to the owner of property adjoining it. This subject has for some time been receiving a great deal of attention from road engineers, and also from a large number of manufacturers who are endeavouring to obtain materials which will enable the road engineers to provide a satisfactory dustless road surface. The first materials to be experimented with in this country were probably the heavy petroleum and coal-tar oils.

Undoubtedly the results were very satisfactory so long as the weather remained dry and warm. The mud formed during wet weather was, however, found to be objectionable, and complaints were received as to injury to coachwork, and so far as I am aware this material is not now being used on any very large scale. Another step was taken when it was found possible to dissolve oils in water and apply them to the surface of the road through an ordinary water-cart. Deliquescent materials, such as chloride of calcium, which have been used for the purposes of keeping down dust in this city for many years, when dissolved in water and spread in the usual way also give satisfactory results. Important trials have recently been carried out near London with tar mixtures and tar-spraying machines, which have been largely attended by the leading road surveyors in the kingdom.

Whilst all these methods of surface spreading are interesting, and may probably be the best way of keeping down dust on existing macadam roads, I look upon surface sprinkling generally, and especially with mixtures which are readily acted upon by water, as merely temporary applications, which, however, are serving a useful, even if only a temporary, purpose in reducing dust on roads; but I think that better and more lasting results are likely to be obtained where the whole of the interstices for a sufficient depth below the surface are filled and the stone coated with a waterproof material.

I feel that I owe some apology to the members of the association for the nature of my presidential address. I should like to have mentioned many matters, and especially the possible openings for the improvement in subjects which come within the duties of the municipal engineer and surveyor, such as the building bye-laws, house drainage, workmen's dwellings, removal of refuse, refuse destructors, and many other subjects which come within our province, but I found that time would not permit me to do so, and I have tried to carry out what I understood to be the desire of the Council when arranging for the conference. I have, therefore, endeavoured to give you some of the leading features which have come under my notice in connection with these matters, and though I feel that I have not been able to throw new light on these subjects, I hope that some good points may be obtained from the experiences of the gentlemen present as well as from the suggestions of members

who may be absent, and that one of the outcomes of the conference may be the drafting of some clauses by the Parliamentary Committee which may be of advantage to our Members and to their various authorities when proceeding to obtain additional parliamentary powers in connection with the improved laying-out of towns, a course which, I hope, most of you will agree is necessary for our growing towns.

CONFERENCE

WITH

DELEGATES FROM VARIOUS LOCAL AUTHORITIES ON THE LAYING OUT OF TOWNS, AND ROAD REQUIREMENTS.

June 20 and 21, 1907.

TOWN PLANNING.

BY C. F. WIKE, M.INST.C.E., CITY SURVEYOR OF SHEFFIELD.

THE development of modern town planning in Sheffield commenced about fourteen years ago, when the corporation took powers to acquire and develop an unhealthy area covering about 4½ acres, situate near the centre of the town. The intersecting streets, which were, perhaps, eighty or a hundred years old, and ran in directions where they were of little use for through traffic, have been replaced with wider ones so laid out eventually to form parts of useful thoroughfares. The acquirement of old property cost 100,000*l.*, or about 5*l.* 8*s.* per yard of land. The population displaced was 1260 persons, occupying 260 houses, and the surplus has since been valued as a site for dwellings at 12*s.* 6*d.* per yard. Model tenements, 124 in number (as well as two sale shops), some with one room, others with two or three rooms and scullery, have since been erected and let at 3*s.* to 6*s.* per week. This involves a loss to the ratepayers, but the Local Government Board insisted on this provision. In addition 57 houses, 3 lock-up shops, and 11 storerooms are now in course of erection, also to comply with the Board's requirements.

Eight or ten years ago the corporation bought other estates, one with an area of about 75 acres, the other of 60 acres. Forty acres of the first estate were bought by auction at 100*l.* per acre. Parliamentary powers were obtained to buy the remainder, and 15 acres belonging to one owner cost over 6000*l.*,

or about 400*l.* per acre. The price was fixed by a jury, and included not only (*a*) the value of the land, and (*b*) damage to remaining land of the same owner through severance, but also (*c*) possible damage through the purchase of the first 40 acres, though the corporation had for two or three years been in possession, and had a perfect right to utilise their property as they thought best, whether they bought more land or not.

This purchase considerably increased the average price per acre, and made the land so expensive that there has since been great hesitation in taking further steps to carry out the original intention of making a main road through the land connecting two districts at present difficult of access, and of developing the remainder for model dwellings, reserving land for a park or open space.

As a contrast, the Author will refer to another case—here the corporation were already owners of the stream, mills, and water rights through a valley 3 miles long. They owned at first a narrow strip with an area of 40 to 50 acres. This was doubled by various purchases. Two winters ago it was desired to start relief works, and as a new road was wanted along the valley, which would not only be a great public improvement, but would also develop the corporation property, more land was purchased and the road started, under the direction of the Water Committee; 34,000*l.* has already been spent upon additional land, and the construction of the road, and here the Corporation have been successful, because the landowners met them.

The other estate purchased, one of 60 acres, was bought privately at 150*l.* per acre. This has been laid out strictly in view of the future development of the surrounding district, and the result may be claimed as a successful instance of town planning under present powers.

The first step taken after the acquirement of the estate was to lay out a principal road connecting two populated districts, and to settle upon the lines of certain other roads. The Corporation then invited competitive plans for cottages, and offered premiums. A plan was selected, and about eighty cottages have since been built, or are in course of erection on the lines of that plan. The cost of these has averaged 265*l.* each, inclusive of land and street works, the latter items representing 50*l* per dwelling. Every house has a site of 200 yards of land,

exclusive of roads, and, instead of dividing this up into diminutive gardens, the buildings have been erected in quadrangles, with a very good and well-kept open green at the rear. The rents are from 6*s.* per week for a house, including living-room, scullery, two bedrooms and bath-room, to 7*s.* 3*d.* for a house with three bedrooms, and in which some of the other rooms are larger. These rents and those of other houses since erected are calculated to pay interest, sinking fund, rates, repairs, and other outgoings without entailing any call upon the rates.

Since then a cheaper class of cottage has been erected with similar accommodation, let at 5*s.* per week. These also have 200 yards of land allotted to each house, and the cost is about 130*l.* each, plus land and street works.

The corporation are still building, and with regard to the remainder of the estate, they have had a site-planning competition, laying down certain necessary conditions, but leaving the details to the competitors. They have accepted the premiated plan, and are now arranging for a cottage exhibition, fifty cottages being in course of erection by private contractors.

So far as these cottages are concerned a further step has been taken with regard to the area allotted to each dwelling; there are to be only twelve houses per acre, and the ground rents, including the cost of road making and drainage, are only from 1½*d.* to 2*d.* per yard of land. The minimum ground rent for the smaller sites is 2*l.* per cottage per annum.

In dealing with these latter plots the corporation have agreed to grant leases for 200 years, but retain the option of purchasing the houses erected upon them at a specified price. This will get over the difficulty experienced at Letchworth, and in other competitions, as any builder may be called upon to sell the whole of his houses to the corporation at the price which he estimated they would cost, not at actual cost price, therefore he is not likely to run very much beyond his estimate, and if he builds them in such a manner as to keep very much below it the corporation are not likely to purchase at the full price.

Experience gained in the above cases shows that something can be done in the matter of town planning, even to-day, though if the question is to be dealt with thoroughly, undoubtedly further powers are necessary.

There seems to be an impression that if powers are obtained the cost of laying out estates will be enormously reduced, and if the land is given or sold at a nominal figure there may be something in this. If, however, the market price has to be paid and the cost of road making added, the advantage will be more in the additional convenience to the public than in any monetary gain. Some one will have to make the roads, and the cost cannot be cut down without a subsequent re-action on the rates. A lightly constructed road may be all very well for a model village in the country, but when suburban areas are to be dealt with, the roads must be substantially made or they will rapidly become a charge, either upon the estate, or upon the rates generally, and if the ratepayers are the owners of the estate the cost will have to be borne by them eventually. Some reduction in cost may be made in giving the subsidiary roads a less width, preserving, however, a good set-back so as not to reduce the distance between the dwellings. An attempt has been made to introduce such regulations in our revised bye-laws, but so far the difficulties have been too great.

The same argument as to cost applies to the buildings. The ornate cottages seen in some parts of the country seem scarcely suitable for their purpose, and while ugliness or monotony should be avoided, it is desirable also not to go to the other extreme, granted that in both cases the workmanship and materials are equally sound. The plain cottage should cost less than the very ornamental one, and the result of inquiries about some of the buildings seen in different model villages has shown that those responsible have not been willing to erect similar dwellings at the price they originally guaranteed to build them for. There is no doubt that cottages, the design of which depends more on good outline than upon elaborate and sometimes meaningless decoration, are much more economical in the matter of repairs.

Another point which might be mentioned is that the development of suburban areas has so far gone hand in hand with tramway extensions, which are undoubtedly now an important factor to be considered in town planning. If authorities are to acquire areas for public development, it should be done in neighbourhoods where travelling facilities will be easy, but the purchases ought to be effected before the facilities are there. If not, a heavy price will have to be paid for the premature

development of the land, notwithstanding that its increased value is due solely to the fact that better means of access have been given.

Another difficulty which will arise is, How are the smaller estates to be dealt with? It may not cause any great injustice to acquire a large estate at a low price, but mixed up with these larger estates are the small ones, and if the small owner is to be deprived of his property at a low price, there will often be an injustice, especially if the owner is also the occupier, and this is contrary to the general spirit of legislation in this country.

ROAD REQUIREMENTS.

By E. P. Hooley, M.Inst.C.E., County Surveyor of Nottingham.

At the present moment it is almost impossible to take up a newspaper, or to talk to any ordinary person, without the question of roads cropping up; the nuisance caused by motors, the damage caused by traction engines, and the increased expenditure on our roads, provide most useful talk for every one. The worst part of the whole matter is that there is hardly a person who has thought over the matter, or even had the experience of a dust storm from passing motors, who does not suddenly blossom out into more or less of an expert, and who is quite prepared, with a very slight encouragement, to tell his surveyor, and the nearest council generally, exactly what ought to be done, how best to do it, and that the whole road question should be tackled, remedied, and re-modelled. When it is only the man in the street ventures this sort of opinion, it is often possible by showing him that his rates will be increased, to at once cause him to alter his views, and at any rate for a time we hear nothing further of his grievance, but when the grievance is dealt with by those who are pleased to pose permanently nowadays as "experts" more harmful results ensue. It is sufficient now to point out, that, without the slightest consideration of the baneful result, Mr. —— writes to the newspapers to inform them that he has discovered that there is a clause in the Highway Act which is quite sufficient to prohibit farmers cutting their hedges, so that a thorn should not puncture a bicycle tyre, and the surveyor is referred to sec. 5 and 6 Wm., chap. 50, sec. 73, and told this entirely meets the case. Reference to the said section will prove that it relates to obstruction and nuisances. Even straining the Act in every point, as almost every man who has ridden on a rubber-tyred vehicle would wish it to be strained, nothing could be found that could

possibly be taken as dealing with the accidental placing of thorns on highways. Or with a loud blast of "official" trumpets, the attention of all councils is directed to a new reading of the Highway Acts—viz. that because motors have come into existence, no hedge shall be allowed to obstruct the view of motorists passing round a corner. The act of 5 and 6 Wm., chap. 50, sec. 64, is again quoted, and put to an absolutely wrong use. Those who are surveyors, having had experience of the difficulties, already in themselves sufficient, of getting hedges cut where they adjoin highways, know but too well, after such a loud blast, it will in the future be still more difficult to get the hedges cut, because on all sides it will be said that they are only being cut for the purpose of encouraging the motor fiend, and, allowing him to scorch quicker round corners. Hedges should be kept low for the sake of the roads, but to try and prostitute an Act of Parliament, so as to put it to the use that is suggested in such a matter as this, is but causing unnecessary trouble.

Then there are those who compare the roads in England with those in America. It has been repeatedly stated that the roads in America are under State control, and America is quoted as an example of what State control means.

Each State in America undoubtedly does manage its own roads, but those States, though cast in a much larger area, but still with similar powers, are but the counties of England, and the management is practically the same as that of our county councils.

These "experts" are, however, occasionally brought to book, and made to state their qualifications. The particulars under this head are too well known to most of those present to require attention to-day, but the "expert" surveyor has yet to appreciate the fact that having travelled over a few hundred miles of road in twelve months, for possibly a special reason of inspecting a few details of road management, without ever having had the direct management of a large road area, would not, by the average surveyor at any rate, be considered a sufficient training to enable one to discharge a man who has spent his life in road management, and substitute this travelling man in his place.

The nett result is that no good ensues in any way or shape; the councils become irritated by the continual holding forth of

these persons; the public are frightened at the expense the councils may be drawn into; and the surveyor instead of endeavouring to overcome the difficulties he has to contend with, becomes so disgusted, that he too often lapses into indifference. There is no doubt a certain amount of indifference exists in road management, and possibly we as engineers are not entirely blameless.

"Going on the roads," "taking to roadwork," "getting a job from the surveyor," are all more or less words of scorn, and most unfair scorn. In days gone by efficient road makers were not looked upon as persons at whom the loafers could point their fingers, but since the advent of canals, railways, and quicker modes of progression, road engineering certainly has been neglected. Refer to any of the professional papers, proceedings or reports of our parent society—the Institution of Civil Engineers—and see how the whole question has hitherto been shelved, but the time has now arrived when roads must again take their proper place in the engineering world, and unless flying machines take the place of the modern speed makers, the main roads will for many years continue to be the anxiety of the surveyor, and the expensive necessity of the public generally.

It is a matter of ten years ago since one could drive over miles and miles of country road and not meet a vehicle. In place of this, to-day, motors are met almost in every country lane, and on our main arteries throughout the country the motor-car is one of the first considerations.

In the neighbourhood of Slough a toll has been taken, and in the course of one hour over 260 motors passed over a given spot. Again, it used to be the exception rather than the rule to meet a traction engine; now, at any rate in the county of Notts, it is almost impossible to travel two or three miles of main road without meeting at least one, if not more, of these most efficient road destroyers. At present motors are looked upon more or less as a luxury of the rich, and while it is an undoubted fact that motors travelling at a rapid rate along an ordinary constructed road considerably damage the surface, yet traction engines, with their heavy loads and serrated wheels, do more damage in one day than a dozen farm carts or fifty motor-cars. Of course, much depends on the weather, but roads constructed as they are at present are impossible for continuous

traction-engine traffic. While motors loosen the surface, traction engines cut into it when loosened, and a day's wet weather is sufficient to make that which has previously been a decent road into one of the worst that it is possible to imagine.

Only this winter, within a few miles of the City of Nottingham, a road that had been previously looked upon as a passable country road—a road unfortunately like many others in the county and neighbourhood, without any real pitched foundation —had to stand traction engine traffic immediately after the break up of the frost, and have conveyed over its surface 800 tons of night soil to a farm. The result was that 800*l.* was expended in trying to reinstate this damage, but there was afterwards no indignation meeting, because the traffic was purely that of the farming interest, though the only persons who have derived any benefits were the traction engine owner, who was paid for the delivery of the material, and the farmer, who obtained his manure at a less cost than he otherwise would have done. If the same amount of damage should have been done in any way by motor vehicles, the shout from the agricultural element would have been loud and long.

There is no doubt with the present road requirements past systems of road making must be altered, or else financial ruin will result. Roads must now be constructed to cope with almost any type of traffic and weather. Not only must the traffic and weather be considered, but the shape of the road must be altered.

It is difficult to point out the result of the present systems of management without going into detail as to how the management has got itself into its present condition. One most important factor is the class of men who have become the road menders of the country. There has been an idea abroad, possibly it is the same idea magnified in the self-appointed experts, that any broken-down tradesman can be placed in charge of a large area of road, and efficiently manage it—that is, as regards the lesser boards—and we as an Association have tried our utmost to alter this opinion.

Allowing the roads to get out of repair for the immediate saving of the rates will no longer, it is hoped, be possible. Systematic road management means systematic application of material, not only in quantity, but in method, and while there yet remain a few councils who look upon steam rollers as needless

luxuries, those councils are certainly few and far between. It seems that this idea of any one being able to manage a road area dies very hard, but if we, as surveyors, continually do our utmost to keep before our councils real and satisfactory road management, instead of the happy-go-lucky systems, it is possible that we shall be able to alter the systems now in force without going to any terrible heroics in cost.

The roads of the past have got to be converted into the roads of the future, and if this can be done without enormous increases in the rates, it will redound to our credit. No golden rules can be laid down as to how this change can be effected, but the experience of one may be useful to another in showing how good results can be obtained, and a short account of the experience that the Author has had in Notts may be useful.

When the roads in Notts were taken over under the direct control of the county council, it was found that no actual system of allowing so much material each year for renewal was in force, and one of the first duties to be undertaken was to arrive at the probable life of each road, and to allot to that road the necessary amount of material to efficiently maintain it for its then requirements.

The character of the traffic on the roads has now altered, so that a road which had previously required coating once in three years has since been found to require coating once every year. Roads that were given a life of five years now only last two years, and the whole of the roads of England to-day have had, by the altered nature of the traffic they have to bear, their life shortened by anything from two to four years.

Continually coating a road to cope with this altered traffic must be unsatisfactory procedure, and the process of converting the present roads into roads of a more permanent character can only be carried out by altering the system to a large extent where the system of yearly renewals has taken place.

In Notts three classes of material are now in use on country roads. Slag, which is obtained from the iron furnaces at an average cost of 6*s.* 1*d.* per ton, Leicestershire stone at an average cost of 10*s.* 8*d.* per ton, and tarmac at an average cost of 12*s.* 7*d.* per ton.

The course the county council have pursued is to reduce as far as posssible the use of the Leicestershire stone, and in its place to continue for the time being to use as much of slag as

possible, so as to divert the money which is expended on granite into a more permanent work of constructing tarmac roads. Here, again, it is necessary to return for a moment to the present method of road construction.

It is next to impossible on roads without foundations to continually roll granite, so that the same may present a level face, and to carry out the work of reforming with efficient foundations all the roads of England would be an undertaking that would even startle the Roads Improvement Association, and when roads are made under the present system they cannot be sufficiently efficient to stand the traffic they are now called upon to bear.

In Notts the procedure that is now adopted is to treat existing roads as if they were the foundations of a new road on which to construct a tarmac water-proof road, and no longer to continue taking sections of roads, but to make five miles of road or so straightforward, and to repair the remaining portion of the said length of road by judicious patching. It will be at once apparent that to carry out such work as this means a large expenditure on a few miles, while the other roads are to an extent suffering. It is hoped that by taking time by the forelock, and commencing operations at once, that we may get ahead of the worst traffic that at present we see looming before us, and that we shall not have to burden the ratepayers with large increases in the county rates. All sorts of trials have been made to make the roads of a satisfactory nature.

It has been found that the amount of moisture absorbed by ordinary slag equals 6 gallons to 1 ton. This alone, after the moisture has frozen and thawed, is sufficient to break the heart of any ordinary road maker, for it is the frost and thaw that assist in completing the damage done by the heavy traffic. It has been truly and often said that the weather is the chief road maker or spoiler.

Water and some form of sand form very large and important factors in the present system of road making, and so long as this continues, with cattle and their leavings on the road surface, so long will the dust nuisance be with us in a greater or less form.

Many and various palliatives, for which all are grateful, have been suggested for dealing with this dust nuisance, and while all agree that it is one of the greatest nuisances of the present day, it seems one of the most fatal proceedings to continue

making roads of a character which is known to be expensive and disagreeable, when waterproof roads can be made at a similar, if not a cheaper, cost, and the minimum of dust results.

After experimenting in almost every possible way, tar seems to be the one cheap and suitable material to form adhesive matter in road construction. Tar by itself undoubtedly would not make good roads, but if tar can be made to adhere permanently to any good road material, and that material can be obtained at a cheap rate, it necessarily follows that many of the expensive parts of road making can be economically dealt with. While looking for a material which would be suitable for road-making and at the same time cheap in its initial cost, the Author found that a large amount of furnace slag was yearly cast to waste, and that by a somewhat simple process all slag, or slag which has been considered unsatisfactory for road-making, could be converted into a hard and truly efficient road material. The difficulty in the ordinary treatment of slag with tar was that the material had to be warmed before it would allow of the tar penetrating its pores, and the more it was warmed the more the tar penetrated, but while this warming process was being carried out the fact of making this slag very hot also made it very brittle, and thus while making it a suitable material for footpaths and light wear, made it a most unsuitable material for road making. It is well known that the slag leaves the furnace in a molten state. In some neighbourhoods the slag is run out into sand beds, watered, and becomes absolutely useless for road material. In some counties efforts have been made to use this watered slag as a road material, and the result can well be imagined; but it is somewhat disheartening when a different material, still called slag, is condemned, very possibly by some of those old users of slag, who stated that they used the material many years ago, and it was absolutely useless, and who will not look at an improved slag because of their past experience.

If, instead of allowing the slag to be water-cooled, the same slag is taken into large cauldrons and specially brought out, it can be obtained almost free from honeycomb. The little honeycomb that does remain is of an exceedingly hard nature, and to a great extent is useful in the manufacture of tar-macadam. In taking up tar, of course, the amount of

honeycomb must be regulated and dealt with, but when slag contains large holes it can be broken up when it reaches a certain temperature, and presented to the tar at the right temperature to hold the tar itself. Thus the heating, which makes it to a large extent brittle, is avoided, and tarmac can be made out of slag second to no tar-macadam, the cooling process absolutely drawing or attracting the tar to the material, instead of repelling it as is usual in cold material.

Hitherto the complaints against tar-macadam have been its slipperiness, and but too often that it will not wear. The Author's opinion is that roads can be formed with a face of material of 1½-inch gauge instead of the present usual ⅝-inch gauge. The ⅝-inch material has no real strength in it equal to the coarser face, and if those surveyors who have so long tried to repair their roads with a finer material would but try to use the coarser material thoroughly well tarred they would soon find that tarmac was not in reality the material sometimes so slightingly spoken of.

Throughout England, of course, the question of railway rates was an important factor in the introduction of the more extended use of this slag from the iron furnaces, but tarmac in the centre of England could be put on the rail at a cost of 8*s.* 6*d.* per ton, which will prove that cheap material is available if the railway rates would only allow of its being used.

The Author is more than anxious at the present time to avoid being in any way understood to be acting as a director or an agent of a company. The information given is in his sole capacity as a county surveyor.

In a neighbouring county where the traffic is nothing like so heavy as in Notts, one of the district councils, years ago, who had been called upon to maintain its main roads, finding that the rates for carrying out the work did not come directly out of their pockets, made up its roads in granite, and expended as much as between 600*l.* and 700*l.* per mile in so doing, although the roads were nothing like as wide as those that have been dealt with in the reconstruction in tarmac of the Notts roads, but the wisdom of their proceeding is plainly shown at the present time, although the cost of the work carried out must have severely taxed the resources of even a merciful county council.

For making up this road, which was one of the most heavily

used roads in the county, being in close proximity to Nottingham, the following figures were ascertained to be the principal expenditure in ordinary making up with granite or making up with a waterproof material :—

	Estimated cost of Grantham Road if it had been laid with granite.	Cost of Grantham Road if laid with tarmac.
	£	£
Materials	7099	6782
Binding	100	—
Manual labour	350	264
Steam roller	350	238
Watering	120	—
Recarting	175	—
Tar, cement, etc.	—	100
	£8194	£7384

The result of this has been that at the present there is a stretch of road which is second to none in the neighbourhood. If at any time any Members of the Association would feel sufficiently interested to inspect this length of road or any other in the course of construction in the county of Nottinghamshire, the Author would be at all times pleased to do anything in his power to show them the result of his experience.

When the question of making tarmac was first considered in Notts efforts were made to make the tarmac at the roadside, but the result was not satisfactory; the material could not be made in sufficient quantities to keep the steam roller going; it could not be properly made hot; and it was only possible to do little sections of road when the whole road area required attention. Only those who know what the management of large road areas means can appreciate the trouble that ensued. Everybody wanted to know why their neighbour's roads were being treated while they were left out in the cold, and even now the petitions that the county council are receiving for more tarmac roads are more numerous than can at present be attended to.

While the county council are endeavouring to economise and to make permanent roads they are not forgetting the dust nuisance, but are hoping in the near future that their efforts for

improved road construction from an economical point of view will meet with success.

A length of road constructed of hot-tarred slag was laid down between the Trent Bridge and the Midland Railway station at Newark nine years ago. Previous to this being laid down the road was in a constant state of being repaired, and generally in a more or less dirty condition, for not only was it the main traffic road but was in close proximity to the market, and the amount of traffic on market day alone was sufficient to keep the road in a filthy condition.

The road was coated over its whole surface at a cost not exceeding one year's supply of granite. This was put down in the year 1898–9, and has only once since received a topping of 1¼ in. material, and to-day is in as good a condition as any country road need be.

One important point not to be missed is the fact that the tarmac road does not require reforming over its whole face like an ordinary macadam roadway, and if in the five miles of road that have been laid on the Grantham Road some small repairs are needed in the next seven years it is all that will be required.

One section has now been down four years, and has never yet had any repairs carried out on its surface, but before the introduction of tarmac this section of road had to be coated every year, and was always in a muddy and dirty condition.

The amount of siding and general cleaning up, other than the removal of horse droppings, has been reduced to a minimum, and it is confidently asserted that no expense within the next ten years will be equal to any one year of previous management, and instead of the road being an unsatisfactory one at all times it is in the absolutely opposite state, although it has to bear increasing traction-engine traffic as well as a constant stream of motors.

NOTES ON TAR MACADAM.

C. F. WIKE, M.INST.C.E., CITY SURVEYOR, SHEFFIELD.

THESE notes are not intended as an argument in favour of better roads. Discussion of road-making problems has recently been so thorough, and the demand for an improvement is so general, that road engineers need now only consider how the desired improvement is to be effected, and how paid for.

The necessity has chiefly come about through the rapid development of motor traffic. Those interested in motors disclaim responsibility for the present dust nuisance and blame the roads, upon which, they say, motor vehicles have no more destructive effect than horse traffic. This, however, will scarcely be admitted by those engineers who have charge of the roads. In the opinion of the writer, the additional wear caused by self-propelled vehicles, and particularly by those fitted with non-slip devices, is considerable. Whether such vehicles ought to pay a larger contribution towards the upkeep of the highways is a question which undoubtedly will have to be fought out and settled.

One effect of the new traffic will be an extension of the paved roads leading out of the towns, and possibly a development in the direction of cheap paving. Another result will be that, where the amount of traffic and rateable value does not warrant the expense of paving, some other construction of road involving the least amount of dust will have to be adopted.

Where paving is too expensive, perhaps the best material for minimising dust is tar macadam, which is by no means a recent introduction, it having been adopted in some of the Northern and Midland towns for at least 30 or 40 years. In Sheffield it has certainly been laid nearly 40 years, and it is with regard to what has been done in this direction that the following detailed observations are offered.

At present there are 392 miles of roads, of which 241 miles

are macadam roads; about 151 miles of the latter are repairable by the Highway Authorities, and, of these, nearly 10 per cent. are laid with tar macadam. The proportion may seem small, but the reason for this at once brings us face to face with one of the difficulties in the general adoption of tar macadam roads.

Many of the roads in the writer's charge have steep gradients, and no one who has had experience of tar macadam will suggest that it is a desirable material for hills. Up to the present a gradient of 1 in 20 has been considered sufficiently steep, and perhaps other engineers will be good enough to give their experience as to laying tar macadam on steeper gradients.

At one time most of this work was let by contract, and this is still the case to a limited extent; but about five years ago a plant was constructed by the corporation at an approximate cost of 1000*l.*, consisting of sheds, iron-plated floors, with flues beneath for drying the broken stone, and heating apparatus for the tar compound. As the information may be useful to others who are thinking of taking the matter up, drawings have been prepared, which accompany these notes, showing the apparatus. During the last three years the quantity of tar macadam prepared has averaged 2300 tons per annum, in addition to 900 tons of tarred chippings for footpaths.

The specification to which the tar macadam is made is as follows:—

1st Coat.—About 2″ in thickness of limestone "dark" in colour, and of approved quality, sound, hard, and free from spar, and equal to sample. The stone to be broken uniformly to a 2¼″ gauge.

2nd Coat.—About 1¼″ in thickness, of best slag, of sound, uniform material, free from honeycomb and dirt, from approved works, all equal to sample. The slag to be broken uniformly to a 1¾″ gauge.

3rd Coat.—About ¾″ in thickness of slag shingle to a ¾″ and ½″ gauge in equal proportions, free of dust, of the quality specified for the second coat, and equal to sample. The total thickness of the tarred material, after being rolled with the steam roller, to be 4″, and the top of its surface to be ¾″ above the level of the channels.

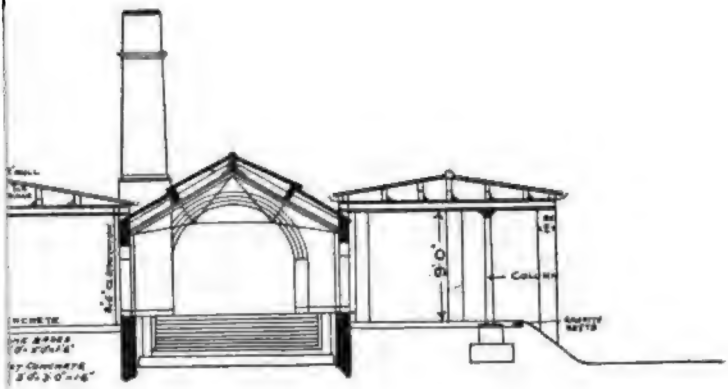
After rolling the roadway is to be covered with a dressing coat of granite or limestone chips (½″ dust out) of approved quality and thickness, as may be ordered, and again rolled.

OF SHEFFIELD

ROVE DEPÔT

MACADAM

NG SHEDS



SECTION.

0 5 10 20 30 40 FEET

ONE INCH = EIGHT FEET

C F WIKE M INST C E
CITY SURVEYOR

[To face p. 288

The whole of the limestone and slag must be thoroughly well dried on hot plates; a mixture of pitch and tar must then be boiled in the following proportion: For the first and second coats 90 gallons tar and 125 lbs. of pitch; and after boiling for two hours, 17 gallons of the mixture must be mixed with 30 cwt. of the broken limestone and 1¾″ slag.

For the third coat 14 gallons of the above mixture, after boiling, to be added to each cube yard of shingle.

The limestone and slag to be perfectly dry and warm at the time of mixing, and the whole thoroughly turned over, so that every part of the surface of the stones will receive a coating of the mixture. The above-mentioned proportions may vary according to the quality of the pitch and the strength of the tar. The prepared limestone and slag is then to be put in separate heaps, and left a sufficient time to toughen before being laid. After it has been properly toughened and freshened with a further quantity of pitch and tar (if considered requisite), it is then to be spread on the foundation in layers as specified.

The cost of slag and limestone tar macadam is about the same. If of the best quality, probably slag is the better material, and, in certain instances, it has been used for all three coats. The difficulty, however, is to get it sufficiently uniform and free from lime and other constituents which render it liable to early disintegration. This is one of its disadvantages as compared with limestone, which can be obtained of uniform hardness, and, as the use of tar macadam increases, so will the difficulty of getting sufficient slag of suitable quality increase.

Granite has not hitherto been looked upon as a suitable material for tar macadam, on account of its want of absorption. It was laid by the writer nearly twenty years ago in several streets, but, for the reason given, was not a success. It has recently been laid in some districts with tarred chips for binding, and similar work is in preparation in Sheffield. If the necessary adherence could be obtained, granite would, on account of its better wearing qualities, be more economical than either limestone or slag, and perhaps, with modern methods of re-tarring roads at frequent intervals, the old difficulty may be got over.

With regard to the cost of tar macadam roads compared with dry granite macadam, the initial cost is about the same, about 2*s.* 3*d.* to 2*s.* 6*d.* per super. yard, exclusive of foundation,

the extra expense of tarring being balanced by the fact that a cheaper material is used than the granite macadam usually employed for important main roads, when these are not paved. Statistics have been prepared with regard to a typical suburban road, taking a considerable amount of traffic, and the annual charge (including initial cost) for a period of fourteen years has averaged about 4*d.* per square yard; this is for a fairly flat road. In another case—a road with light traffic—the average has been a little less than 2½*d.* per square yard.

If the best results are to be obtained, it is very advisable that, after the first laying, tar macadam should be kept in thorough repair, and for many years it has been the practice to tar paint the surface at intervals of three or four years, or as soon as roughness begins to show. This has been done not so much with the idea of laying the dust as to prolong the life of the tar macadam.

At present a considerable mileage of dry macadam road is being tar sprayed, and, so far as can be seen at present, it will be practicable to apply this system to gradients steeper than those upon which tar macadam has been laid. Nevertheless, there must be a limit to the gradients upon which tar can, in any form, safely be employed, as it is a material very susceptible to heat, and slippery in hot weather.

To sum up the writer's experience, tar macadam is a very suitable and economical material for many situations, and its use is bound to increase, but it has its restrictions, the principal one being that it cannot safely be used for roads with a considerable gradient. So far, the materials used have been inferior in durability to granite or whinstone, and therefore it has not been suitable for macadam roads with the heaviest traffic. The great advantages are the comparative absence of dust, and the quietness. Tar macadam roads are also economical in the matter of cleansing. The introduction of tar-spraying apparatus has materially helped to minimise the dust nuisance, and it is through the application of tar, in one form or another, that the nearest approach to a dustless road must be looked for, where paving (which, after all, creates the least dust) cannot be used.

ROAD REQUIREMENTS OF THE FUTURE.

By JOHN S. BRODIE, M.Inst.C.E., Borough Surveyor, Blackpool.

Introductory.

It is quite unnecessary, before a Meeting of the Association of Municipal and County Engineers, to dwell on the past history of our highways, and it is only incidentally necessary to describe their present condition, as we are all quite familiar with both. The Author will, therefore, enter at once on the subject of these notes, only premising that the suggestions here set forth are intended more as bases of discussion than as settled opinions, and, on this understanding, the Author trusts that his brother Members will not be sparing in their criticism, because it is only by the fullest discussion and the consequent formation of a strong and well-informed public opinion that good progress will be possible in the future.

Why Improvements are Necessary.

Now, why is it necessary for us to reconsider our methods as practical road-makers? How is it that, in our "inmost minds" we ourselves are distinctly conscious that the time has arrived when it is imperative upon us to "mend our ways"?

Is it not that, within a comparatively few years, our brethren of the mechanical branch of the profession have "been toiling in the night" towards perfection in locomotion, while we, if we have not exactly "slept," can hardly be said to have done more than keep a watchful eye upon the efforts of our brethren aforesaid, and to be somewhat surprised at the results which they have already produced.

But for the advent of the self-propelled vehicle on our highways, during the past decade, it is possible that we would still be in a state of comfortable self-satisfaction with methods

of road-making, as introduced in the beginning of the last century, and which to-day in country districts generally prevail, although here and there, successful efforts have been made to make roads that should be at once clean and noiseless, as compared with the great majority of roads which are neither the one nor the other.

The voice of the town dweller has been raised against mud and noise, while the cry—sometimes the exceeding "bitter cry"—of the wayside residents in the country against the dust clouds raised by the new self-propelled and swift vehicular traffic, has attained almost the volume and dimensions of a "mandate from the people" for its prevention or cure.

Again, the only too successful efforts of our friends the mechanical engineers, to literally "kick up a dust" with their motors, has, in an indirect way, done surveyors a great deal of good, inasmuch as our respected masters, the ratepayers, have had such convincing ocular, not to say nasal, demonstration of the unsuitability of roads made of a compound of stone chippings and the cleanings out of the roadside ditches, or some similar abominations, as to carry forward their convictions in the direction of better roads, with a velocity which we officials in control of highways must have despaired ever to accomplish in any reasonable time. The Author can bear testimony that he has been preaching the doctrine of the advantages of impervious self-cleansing and noiseless roads to Highway Committees unceasingly for the last twenty years with only very qualified success, and he feels that his experience must be that of many of his brethren. He therefore hails with satisfaction, the present demand from practically all quarters, to lay the dust demon, and to abate, if not abolish, the noise nuisance.

Again, an important and rapidly increasing section of the community, duly impressed with the necessity of rapid transit, both as regards business and pleasure pursuits, having by the achievements of our mechanical confrères, possessed itself of vehicles adapted to accomplish that object, loudly calls upon those in authority to provide corresponding roads, so that speeds of from 12 to 15 miles per hour may be secured for heavy motor traffic, and from 40 to 50 miles per hour for light vehicular traffic.

WHAT THE PUBLIC WANT.

We have, then, from our masters, the public, a clear demand for three primary and essential conditions of the highways of the future, viz.—

(1) They must be free from dust in summer and from mud in winter.

(2) They must be practically noiseless under all conditions of traffic.

(3) They must be such that everyday motor-car speeds of from 40 to 50 miles per hour upon them must be practicable and safe.

All other conditions, such as cost, durability, cross section, gradients, foothold, etc., are secondary and subsidiary, and are largely dependent on local or special circumstances and requirements.

Now, who shall say that these requirements are either impracticable or unreasonable? Are we to go on being bespattered with mud or blinded by dust? Are we to continue in our business and residential streets to be deafened with the noise and clatter of stone paved carriage-ways; and are we to be satisfied with the slow rate of travel of bygone times for which our present roads were made, and for which *only* they are suitable? Most assuredly not.

SUGGESTED REFORMS.

How then are the above essential conditions to be attained?

The complete answer to this question must be at least threefold, viz.—

(A) By the use of suitable materials and the application of correct principles of road making.

(B) By efficiency and economy of administration.

(C) By adequate and just financial arrangements, so that the burden of cost may be equitably adjusted among all classes of the community.

It will be convenient to consider the subject under the three divisions enumerated above.

(A) *Suitable Materials, etc.*

It must be clear that any so-called road material which rapidly wears under traffic into fine particles is unsuitable. On the other hand, it is evident that some of the harder natural rocks, and artificial products, are equally objectionable on account of noise and slipperiness. Again, any material which is highly absorbent of moisture must be ruled out as unsuitable on sanitary and other grounds.

The Author does not, in these notes, propose to submit to his brother members of the Association a complete and final solution for all time of all the difficulties connected with road making.

Briefly, the result of many years' experience has led him to the following general conclusions on the subject, viz.:—

(*a*) For comparatively heavy traffic, especially in Urban Districts, a pavement of wood blocks properly treated and laid on a suitable foundation of Portland cement, concrete; and

(*b*) For comparatively lighter traffic, a tar asphalte pavement, laid on a bed of hand packed rubble, most nearly comply with the conditions stated above.

It cannot be successfully contended that either of the above methods of road making are impracticable by reason of their excessive cost.

During the last six years the Author has laid nearly 150,000 square yards of Australian hardwood (Karri and Jarrah) paving of an average depth of 4½ inches on a foundation of Portland cement concrete 6 inches in depth, at an average cost of 10*s.* 1*d.* per square yard for paving, and 3*s.* 4*d.* per square yard for foundation, or together 13*s.* 5*d.* per square yard.

During the same time he has laid about 56,000 square yards of tar asphalte of an average thickness of 5 inches on a foundation of hand packed rubble 7 inches in depth, at an average cost of 3*s.* 2*d.* per square yard for asphalte, and 1*s.* 9*d.* per square yard for foundation, or together 4*s.* 11*d.* per square yard.

Both have given complete satisfaction, and incidentally, it may be stated that the European record for highest speed by racing motor-cars over the flying kilometer was made on part of the above asphalte, on October 13th of last year, under the most unfavourable climatic conditions of a strong head wind, and rain, when the measured kilometer was run in 21⅖ seconds, equivalent to a speed of 104½ miles per hour.

(B) *Administration.*

Much unfavourable criticism has been indulged in lately as to the absence of uniformity of methods employed in highway administration. Some of the suggestions made to remedy the evils complained of have, no doubt, been wise; and some have been far *otherwise.*

It is not untrue that some of our present Highway Acts are far from perfect. To take one instance only, the Author certainly congratulates himself and other surveyors to county boroughs, as compared with county surveyors and surveyors to non-county boroughs and local districts. In the latter, there is unfortunately, that divided authority between county and district interests as regards main and secondary roads which has only been made workable, and in many cases successful, by the good sense and tact of the surveyors and other officials concerned.

It is admitted that on the whole good results have been obtained under the present Highway Acts, notwithstanding difficulties such as the above, and although in theory the direct control and maintenance of highways by the State may appear to have many advantages, yet it must be remembered that the genius of the people of this country is in favour of local as opposed to State control, just as the reverse is the case in most Continental countries.

Local administrative bodies, in this country, could only consent, if at all, to State control of their roads, or part of them, on condition that the entire cost of their maintenance and improvements were paid for by the State.

On the other hand, the State could only undertake such a great financial responsibility as the above by safe-guarding its interests through direct control over the spending of the necessry funds raised by taxation either direct or indirect.

In the Author's opinion, the simplest and most efficient arrangement, whereby economy of administration combined with proper financial control, would be for the State to take up, over the whole country, as regards highways, a similar relation to the county and county borough councils as the present county councils occupy in relation to non-county borough, urban, and rural district councils. By this means, all the present administrative machinery would be available, and only

general State control and direction over the expenditure of State Funds would be necessary. Thus the county councils could continue to make contributions to secondary district roads as they do at present, and could supervise the expenditure of State contributed money on new or existing main roads in accordance with, and to the satisfaction of, a State department of national trunk or main roads.

Financial Arrangements.

The history of the incidence of taxation for the purpose of raising funds for maintaining and improving highways can only be very briefly glanced at, if at all, in these notes.

The ordinance or Act of 1654 (the time of the Commonwealth) appears to have been the first legislative attempt to make an assessment for repairing highways. The first rating area was the parish, and the first ratepayers were the holders of land. If the parishioners, after due notice given in church, failed to assemble and levy a rate not exceeding one shilling in the pound, the surveyor (happy man) was empowered to levy it himself, and (presumably) was invested with sufficient authority to collect it. From this beginning the administrative and rating area was gradually extended from one parish to a group of neighbouring parishes, forming the latter-day highway district, by many successive Acts of Parliament, culminating in the great Highway Act of 1835.

Then, by the Highways and Locomotive Act of 1878, an important innovation was introduced on the hitherto accepted principle of throwing the burden of repairing the roads entirely on the districts through which they passed.

By the latter Act, half the cost of maintaining certain defined "main" roads within the administrative county was to be borne by the county council, and the half cost was increased to the *whole* cost of such "main" roads by the Local Government Act of 1888, which further authorised the County Council, if they thought fit, to contribute towards the cost of maintenance of *any* highway in the administrative county area, although the same was not a main road. To meet this cost the county councils had allocated to them by the Imperial Exchequer, the duties on local taxation licenses, collected in each county, under the Customs and Inland Revenue Act, 1888, which

included taxes on motor-cars; and the Locomotives on Highways Act of 1896 imposed additional taxes on motor-cars.

It will thus be seen that a great advance has already been made towards realising the two great principles of rating for highway purposes, viz.—

(*a*) The liability of the district through which a road passes for a proportion of its cost of maintenance.

(*b*) The liability of those who benefit from the *use* of the road for their proportion of its cost of maintenance.

Now, why not go a step further, and fix the liability of those who do *most damage* to the surfaces of the roads, in a separate and clearly defined rating class, viz.: The traction engine and motor-car. Let all traction engines and motor-cars be taxed in direct proportion to their weight, and in inverse proportion to the widths of their wheel tyres, and let all the revenue thus derived be devoted to repair the damages caused to the roads by self-propelled vehicles.

Ample funds could be raised on some such lines as are roughly sketched here which are really only extensions of principles already adopted in the Motor Acts of 1906 and 1893, and broadly, though not exactly, in the recommendations contained in the Report of the Royal Commission on Motor-cars of last July.

Such a scheme of rating as is here suggested, would be fair and equitable to all classes of the community.

NOTES ON THE TAR-SPRAYING TRIALS.

By FRED W. PEARCE, F.S.I., Surveyor to the Urban District Council of Twickenham.

The trials which form the subject of these notes were carried out under the auspices of the Roads Improvement Association, acting on behalf of the Royal Automobile Club and the Motor Union of Great Britain and Ireland, on the 22nd, 23rd, 24th, and 27th of May last, in connection with competition tests for (1) the best tar-spreading machine, and (2) the best preparation of tar for road purposes.

The tar-spreading machines were tested on three classes of road surfaces, viz. macadam, flint, and gravel, the particular roads upon which the tests were made being—

(*a*) The Hounslow and Staines macadam road, under the control of the Middlesex County Council;

(*b*) The flint road between Twickenham and Kempton Park, under the control of the Staines Rural District Council; and

(*c*) The gravel road between Virginia Water and Reading at Ascot, under the control of the Berkshire County Council.

The preparations of tar were tested on the macadam road only.

The machines entered for the tar-spreading competition were Aitken's Patent Pneumatic Tar-Sprayer; the Emulsifix machine; Johnston's Lassailly Patent Tar Road Binder; the Tarmaciser; a 700-gallon "Tarspra" Thornycroft motor van; a 1000-gallon "Tarspra" cart, drawn by motor tractor; a 200-gallon "Tarspra" cart, drawn by two horses; and the Thwaite Anti-Road Dust System. Owing, however, to an unfortunate accident, the Tarmaciser was unable to take part in the original competition, and arrangements were subsequently made for such machine to be tested separately at a different time and place to that fixed for the original tests.

The method of distribution adopted in each of the machines

will be briefly described, and may be classed under the following headings:—

(1) Spraying the tar on the surface of the road under pressure through nozzles or jets, the tar having previously been heated in the machine.

(2) Similar spraying of cold tar or tar heated in a separate boiler.

(3) The distribution of tar through jets or perforations, uniformity in distribution being secured by regulating apparatus and by automatic brushing with weighted brushes fitted at the rear of the vehicle.

(4) The emulsifying of tar oils and water in a tank by means of revolving blades and the distribution of the same on to the roadway by a van or cart fitted with sprinklers or distributors.

The preparations entered for the second part of the competition were Crempoid, a mixture of glue and bichromate of potash with coal tar; Clare's Patent Tar Compo, specially prepared tar with certain impurities extracted; Ermenite, a mixture of cotton-seed oil, sulphuric acid, and crude tar, subsequently emulsified with hot caustic soda solution and applied by an ordinary water-cart after mixing with water; Oil Gas Tar; Hahnite, a combination of carbolic acid, oil, asphalte, tar, etc.; Pulvicide, a compound of creosote, pitch, resin, and caustic soda or caustic potash, subsequently emulsified with water and applied by means of an ordinary water-cart; Marbit, composed of crude coal tar and a specially prepared form of natural bitumen; and Solidified Tar.

The trials were carried out under very adverse conditions with respect to weather, and have in consequence been deprived to some extent of their usefulness. The element of wet weather has, however, an important bearing upon any material or method of application which may be suggested for general adoption in this country.

The general results of the tests, so far as they can at present be dealt with, appear to demonstrate the advantages of an efficient method of distribution in obtaining sufficient penetration of the road surface, and the disadvantage of the use of materials which are easily washed off the surface in the event of a heavy rainfall immediately following the application. The efficient preparation of the road surfaces is of considerable

importance, and the best results appear to be obtained on the macadam road.

It is hoped that it may be found possible to arrange for further tests to include materials other than those containing tar, and it is suggested that certain of the conditions imposed might be modified with a view to giving greater facilities to competitors to carry out the work on their own lines.

DISCUSSION.

Mr. J. Walker Smith: I have myself had fairly extensive experience of tar macadam, and I am at one with Mr. Hooley and also with Mr. Wike that tar macadam, in some form or another, is the form of road construction in the future. I grant, too, it is dustless, noiseless, it is economical in scavenging and maintenance; also that with properly selected materials, its first cost is, at least, no more than the cost of ordinary macadam construction, and if one has to pay heavy freight for first-class granite for the ordinary construction, then tar macadam, even in the first cost, would be cheaper. At Barrow-in-Furness we have recently amended our standard specification for the construction of streets in the future, and no street will be constructed other than of tar macadam. I think we have now managed to make a tar macadam which, even if it be not capable of standing the very heaviest traffic, is certainly capable of standing very considerable traffic of motor-cars and motor-waggons. I have myself tried tarmac, and I have a sample which is laid alongside a sample of our own preparation. Certain costs and estimates have shown me very conclusively that this tarmac does wear fairly well, but much more rapidly than tar macadam, the top coat of which is constructed of granite. When I use the term granite I use it colloquially and not geologically. I do not mind what it is so long as it is tough—toughness as opposed to hardness and brittleness—and so long as it is of a rough jagged fracture; for the bottom layers generally a good local material can be obtained—not necessarily slag or limestone, although either of these two materials will do admirably. Sufficiently mix this aggregate with a suitable matrix—without specifying for the moment what that matrix shall be, save that it shall be a tar

compound of some kind—and spread about four inches of the tar macadam, thoroughly well roll it, and on top of that place some thoroughly well mixed tar and granite chippings. I have had roads constructed to such a specification for the last three or four years. The last one was constructed about two years ago; this will be its third year, and I have found it necessary to do nothing to that road until this year. If we should be fortunate enough to get two or three fine days this summer, I shall have to paint it with a proper solution of tar and pitch, and spread it over with granite chippings. I have been particularly interested in the specification which Mr. Wike gave here for tar macadam. It is almost as good as my own, and is better than most. I cannot for the life of me see why Mr. Wike and Mr. Hooley should be so fond of slag. I have used thousands of tons of it yearly for the last five years. Its composition, chemically and physically, is ever changing. You rarely get two or three lots alike. It changes in different parts of the country, and it may change considerably from year to year with the ores and processes. Mr. Wike's foundation and finishing coat are of this slag, and he proceeds to specify other materials—tar and pitch—all delightfully vague, and both absolutely unknown quantities. Take tar for instance. I should never think for one moment of using tar as he does. Some people think they can take it as it leaves the gasworks, He, Mr. Wike, specifies for tar macadam containing approximately like proportions of tar and pitch for all layers, but you cannot specify mixture in that way—the same mixture for the bottom coat as the top—even if the matrix itself is properly specified. In the first place, for the bottom coat you want something very hard. You want plenty of pitch there, or to so boil your tar that it becomes more or less pitch. For the top surface you want something quite different. You want hardness, but in the sense of toughness not brittleness. During the President's address I learned for the first time that some one had attempted to standardise the matrix for tar macadam. I think that is a most important step—a step in the right direction. When one is using tar and pitch one never knows what one is using. Tar will vary with the different coalfields. Pitch will change not only geographically but also temporarily. It will all depend upon the amount of oil of various grades that the distiller can find a market for. He gets the tar from the

gasworks, he takes out of it whatever he can find the best market for, and in the residual pitch one does not know what proportion of creosote oil or other oil is contained. I do hope that the matrix will be standardised. Keep on distilling your crude tar, driving off the ammoniacal liquors and light oils until you get a certain specific gravity—predetermined by experiment—and you will then find you will have standardised your matrix. Then, and not till then, will you be able to command success in tar macadam.

Mr. A. J. PRICE: I quite agree that the road of the future for light traffic will be tar macadam. On sanitary and economic grounds, and for vehicular traffic, it will be almost an ideal road. I have been rather surprised to hear that Mr. Wike and Mr. Hooley say that they are not able to make tar macadamised roads of granite. If they will come to Lytham, I will show them a granite road which has been made fifteen years, and another of five years' standing, and if they can show me a better road with slag I shall be very much surprised. I have seen some two or three roads of slag, and I do not think they are any better than roads I have made with granite. The question of a tar macadamised road's success or otherwise will depend altogether upon the way in which the tar is boiled. Mr. Hooley has said he does not believe you can take tar from the gasworks and make good macadamised roads. I should not think of using pitch and creosote oil if I can get properly distilled tar. The tar I get is not always distilled in the condition in which I wish to use it, but it is somewhere near it, and by either boiling a little harder, or adding raw tar if it is too hard already, we can make it of the consistency we require. One thing about tar is, you cannot get any chemical formula which will give you tar you can use in all situations. If you are doing the top of a footpath, and you are going to use fine material, you must pick holes in the bottom coat if it is a hard one, or you must make the tar a little harder, and use less, so that it will not come up with the traffic upon it. If you use pitch and creosote oil you almost invariably get it too hard. If you get too much of the lighter oils in with hard traffic upon it, it will come to the top. With regard to having large stones at the top and putting small stones underneath, my opinion is—and I have thought a good deal about the matter—if you are going to have a successful road you must have a close top. I

have seen a road made of tar slag macadam. I went to see it eighteen months ago and I thought it altogether too open, and if water got in it would soon disintegrate. What we have to do is to get such a surface that water will not penetrate. Personally I put on the material in two coats, the bottom coat being formed of two inch to half-inch stone, thoroughly mixed, and I have been using this for several years. When I went to Lytham I found a large mass of granite chippings which I had to use, and I put it into the bottom coat to get rid of it. It filled up the interstices in the bottom, and therefore the top coat was not so liable to roll into holes. I use quarter-inch and half-inch for the top coat when road-making so as to get a close top. Another thing is, if you want to get a good road you must have it well rolled. Anybody having tar macadam to deal with knows that, within reason, the more traffic the road gets upon it the better surface you get. When we are treating with contractors we frequently cannot get as much rolling as we like. I was a little surprised to find that Mr. Wike takes almost as much tar for the bottom as the top. Personally I use at least 50 per cent. more for the top than the bottom, and that is the experience of most people. The cost of making is about what Mr. Wike has given. I cannot understand Mr. Hooley's experience in tar painting. He either has not known how to boil the tar, or he has had a most unfortunate experience. I have got a length of 1300 yards done in Lytham, and I believe I was one of the first surveyors in the north of England to deal with the matter. Some I have had done for two years. That road is in a fairly satisfactory condition now. The tar is working off in parts and exposing the macadam, but the effect of the tar can be seen yet. We have had no complaints or questions of damage, simply because the tar was properly boiled. I have also done two lengths with limestone and granite chippings—150 yards of each, the granite being quarter-inch chippings. Owing to the limestone being a softer material, for two or three weeks it was almost as bad as an ordinary macadamised road, so far as dust was concerned; after that it went all right. The granite dressing I put on acted very well. There was no dust from it from the beginning. It went into the tar very well, and it is practically now like an ordinary tar-macadamised road. I can quite understand that you can get over a great deal of ground with a tarmaciser.

I did mine in a very simple way. I got as much dust out of the road as I could with the sweeping machine, and then I got the tar boiler on the job, and used a watering can to sprinkle the hot tar, and worked it in with hard scavenging brushes, and rolled with a ten-ton roller. I have done 10,000 square yards of it. The cost worked out at 1½*d.* per yard, and I think any one will agree it is a satisfactory job.

Mr. F. W. PLATT (building surveyor, Salford): The Salford Council has recently given a great deal of attention to the development of the outer parts of the borough. In the borough of Salford there are about 1200 acres of land not yet built upon, practically about a quarter of the borough. The borough is fairly well supplied with main traffic roads, but great difficulties in times past have been experienced in coupling up the different estates, although Salford is, perhaps, in an exceptional position, in having the land in the hands of few owners; there being only about three great owners, one of whom owns a third. Yet with this advantage, I do not know a case where more difficulty has been found in coupling up the various parts of the borough, and in joining these estates together to provide properly communicating roads. This led the Council to instruct the Buildings and Bridges Committee to investigate what is being done in other places. Inquiries have been made, extending to the Continent of Europe, as well as to the Continent of America. The German system has been very thoroughly investigated. Perhaps a word about the German system might be useful. In England we have not a great number of small landowners, the same as they have in Germany. In Germany, in order that the Act of Parliament known as *Lex Adickes*—under which the German towns deal with building areas—can be carried into effect, it has been found necessary for the Town Council, before they have prepared those building schemes, which were so ably propounded by the President in his address, to appropriate the land of the respective adjoining owners. The building scheme provides that after the trunk roads have been formed, the land remaining shall be laid out exactly as the local authorities require it without any such limitations as we have in England. I want to emphasise the method of laying out the land. The streets and roads having been laid out, the land is then divided or expropriated amongst the original respective owners; some compensation

being found necessary in a few cases—but in a very few cases indeed—owing to the land having acquired an increased value by the collective laying-out. The result of these schemes is, that in the older parts of the town, and consequently in the most crowded, there is a free passage of air from the less densely populated parts. To ensure the successful future development of the British race means primarily the wiping away of all slums. If this is done intercommunication from town to town can be accomplished. First of all is the need of providing for great trunk roads. Can we do anything like that under the Public Health Acts? I believe not. I have just come back from London after an interview with the Local Government Board officials. My committee wanted a simple thing like this, that there shall be streets not less than fourteen yards wide, and that those streets shall be intersected at every seventy yards by a street of the same width—a not unreasonable proposal. Picture what this means. A town laid out in areas or blocks, each about an acre in extent, and bounded by streets fourteen yards wide! You can at once show how many buildings you expect to have upon the land; you can, moreover, provide for each grade of town dweller. And further, you have got a place which can be easily cleansed, and through which one can freely pass. And what does the Local Government Board say to such a proposal? "We have never, by provisional order, extended the section of any Act of Parliament to do that"; and further, that "Parliament has never granted the right of requiring intersecting streets excepting at greater distances than 120 yards." They say Parliament has never created such a precedent. But what is your hope? Will Parliament give local authorities something very much greater than anything they have asked before? I believe if an association such as this will press forward a question of this kind, you will rouse public opinion to such an extent that you will get what you want from Parliament. My Council wish to have trunk roads eighteen yards wide. Eighteen yards is not very much. As a native of Liverpool, I am very proud to see the map displayed in this room of the new Queen's Drive, 36 yards wide. I know the district very well, and, if I may say so, I think that it is a magnificent scheme. I wish Liverpool may go forward and overcome, with the aid of their engineer, greater difficulties even than that. That is the sort of road we need, but the Public Health Act

gives us no power to acquire such an one, and the Public Health Amendment Act does not help us in the least degree. If you go to the Local Government Board you are told you cannot do this under the Public Health Act. Many men think it is a good thing to allow local authorities to have such powers as the prescribing of the length, width, course, and direction of streets, and I believe public opinion must move the Local Government Board to ask Parliament to give such powers to local authorities. I think local authorities should have more control in the question of elevations of buildings. In this matter we must not, however, here forget that a local authority is a constantly changing body. If you are going to be successful in anything you must have continuity of thought. Have we got this upon our councils? With the aldermanic bench you have provision made for continuity of thought; the principle is right. My point here is, in order to get Parliament to entrust you with greater powers, you must show that you have continuity of thought, you must have suitable men upon the councils. Then you may go to Parliament with confidence and say: "Give us such powers to prescribe how buildings shall be erected, so far as elevations are concerned, which part of the town shall be devoted to business purposes, which part to schools, which part shall be allocated for dwellings, which for more houses, which part for factories," and so on. My Council has done something towards this, and I think it is unique; I know of no other Council, except that of Great Grimsby, which has done so. A large area—about 600 acres—approaching the docks, is exclusively reserved for business premises, and no houses whatever can be erected upon it. Land there, which some ten years ago was worth 2½*d.* per yard is now worth 2*s.* a yard chief rent. And what does that mean to the local authority? Increased prosperity and rateable value. All roads on this area will be kept in repair by the landowner, and thus provide for a saving on the highway rates and other money, which can be spent in public improvements. I hope this Association will make its voice heard, and will use the influence it possesses to get Parliament to grant powers to local authorities, such as I have briefly outlined, for the development of building areas throughout the Kingdom.

Mr. H. T. Wakelam: Representing a county bordering on the Metropolis, I feel very greatly interested in this question of

the development of towns. That part of Middlesex joining the boundary of London proper, as you know, is practically becoming a huge town, and if something can be brought out from this discussion that tends towards the consolidation of thought in that county, it will, no doubt, in years to come, be very greatly appreciated. At the present time it is going along, and, as you know, very rapidly, but there does not appear to be that continuity of thought as has been suggested. We heard from the President's address that in Liverpool large sums had been spent in the direction of road widenings for the purpose of tramways. If such a principle as the last speaker outlined had been followed years ago, that expenditure would not have been necessary, as it also has been to a very large extent in Middlesex. In connection with our tramways during the last five years we have had to spend nearly a million of money in widening roads to a width of 50 feet to accommodate double tracks of tramways. We find the trunk roads of the county ought really to be of even much greater width than 50 feet. Some time ago I sent to my committee a scheme something on the lines of that 108 feet suggested road on the wall diagram displayed. I am also glad to see a diagram of the Sigburth Road, Liverpool. That particular road was under my own charge some years ago, and I know the difficulties that were experienced at that period in connection with the traffic along it. I am very glad to see the efforts in connection with the city's departmental work have been so successful as to get the Corporation to widen the road and lay it out in the manner they have done. I am quite sure the local people will appreciate it very greatly. We have heard a good deal about tar macadam and tar painting. Taking the latter, I may say that we have practised tar painting road surfaces for about three years in the county of Middlesex, and I am happy to say we have not had the failures outlined and alluded to by Mr. Hooley. So far from its being a failure, we have received in the past two years memorial petitions from several districts signed by large numbers of road users asking us to tar the road as in the previous years. As to the question of tar macadam, I am sorry to say I do not altogether hold the views expressed by Mr. Wike and Mr. Hooley with regard to slag. Slag has certainly not been the success with me with regard to tar macadam, as has been tar macadam made with granite. Within the precincts of this city seventeen years

ago a road was laid with tar macadam made with granite and limestone chippings. I believe that road lasted until about twelve months ago, so that tar macadam made with granite will stand as stated by Mr. Price. You, sir, referred more particularly to the difficulties you had with regard to the widenings of your roads. I am sorry to say the procedure with regard to road widenings is a very difficult point to overcome. Last year Middlesex had a Bill in the House to secure powers to widen the main urban roads of Middlesex, and also other main roads under the direct control of the County Council. Such a Bill was necessary in view of the traffic along those particular roads. We went before the Committee of the House, and we were met by the representative of the Local Government Board. We spent a lot of money in connection with the Bill, and it resulted in our getting very much reduced powers to those we asked for. If something can be done in the direction of securing the widening of roads without having to go through the cumbersome procedure we have to go through at the present time, I am sure something will be done which will be greatly advantageous to the inhabitants of this Kingdom in years to come. A difficulty also in connection with widenings is recoupment and betterment. That, as you know, is a very great difficulty. Large bodies like the Corporation of Liverpool, no doubt, have to acquire properties for widenings, and they, no doubt, have some of them left on their hands for considerable lengths of time, and instead of getting the proper recoupment they ought to have, they, no doubt find themselves, as we have done, left in charge of properties of which there is no hope of our getting anything like the money we ought as a set-off against the expenditures we have had to make. With regard to the improvement of main roads, any one would welcome a scheme for the improvement of roads at a reasonable cost. In Middlesex the main and subsidised roads cost us something like 90,000*l.* a year. When the county council came in first of all these roads were costing 49,000*l.* a year to maintain. That shows the trend of increased traffic, and also that we are endeavouring to do as much as we can to meet the increase. We have in the last five years put down something like 100 acres of wood paving on the roads in connection with improvements and tramways, and still the cry is: "We want more." All I

can say is, that I do not know where the money is going to come from to give it.

Mr. Ald. A. G. TURLEY (West Bromwich): I have been very much interested in the question of tar macadam. We got our Surveyor, Mr. Greatorex, to experiment upon the high road which is the main road to Birmingham, and one of the hardest-worked roads in the district, and he put on the road two coats of four inches of slag and tar. It has been down now for twelve months, and it seems in better condition to-day than when it was first put down. It has certainly stood exceedingly well. As regards the widening of streets and roads, many of us have a legacy of these narrow streets, and we have no remedy for them unless we expend a great deal of money. I do think in the future, when any new ground is taken and new roads are made, we should go in for them being as wide as we possibly can make them.

Mr. E. G. MAWBEY: I am sorry I have to apologise for the absence of Mr. Alderman Patey, the Chairman of our Highways and Sewerage Committee. We have discussed the matter many times, and I regret he cannot be present. What we think is, that undoubtedly local authorities require new powers to control the planning, and in fact to design the laying out of the main thoroughfares and streets in the extension of the suburban parts of their town and districts, for there is no general power applicable to local authorities at the present time. It is quite true some towns have special clauses and bye-laws, which are more or less helpful, but it is doubtful whether any of them go far enough.

It is high time Parliament gave the country legislation empowering local authorities to practically plan their own town extensions, and to cause land and property owners to fall into line with general schemes of comprehensive planning suitable to each respective town or district.

At the present time in the laying out of estates each landowner, as a rule, plans his estate with little or no consideration for the development on proper lines, for the convenience of the public, of adjoining estates. Neither can he, with perhaps rare exceptions, be compelled to submit any general scheme for the laying out of the whole of his estate, or showing how it will work in relation to any probable future streets; although some corporations and local authorities do succeed in obtaining preliminary

plans. In Leicester, for instance, I must say that we have been more or less fortunate by the public spirit shown by some of the largest landowners in this respect, although we have had our difficulties to contend with.

The result of these inadequate powers is that portions of towns must either remain congested and inconvenient for general traffic, and frequently insanitary, or the present and future communities must expend vast sums of money for street and road widenings and public improvements, which improvements form at the present time one of the greatest burdens on the ratepayers, in consequence of the unsatisfactory planning and want of foresight and power in the past.

By the Leicester Improvement Act, 1881, we have power to vary or alter the intended position or direction of an intended new street for the purpose of securing more easy and convenient communication with any other street adjoining or leading thereto, or for the purpose of making such new street to communicate therewith at a more convenient level.

A few other towns have similar powers; but these powers, even if universal, would not meet the case of enabling corporations to determine and control the general planning of new thoroughfares and building areas.

Powers are also needed to substantially reduce the number of houses which may be put upon an acre of land, so as to prevent the present insanitary system of crowding a maximum number of houses upon a given area, so long as speculators can manage to provide the present very inadequate area of 150 to 200 sup. feet (and other dimensions) of open space required by the majority of bye-laws at the present time in force.

There is a strong feeling arising that local authorities should also have power to themselves acquire land in their suburbs to enable them to facilitate better methods of town planning, and the acquirement of cheaper land for the housing of the working classes, and greater areas of open space thereto, to secure more healthy and sanitary conditions for the people.

Every means should be adopted to bring down the present high prices of building land, and as was pointed out by Mr. Councillor Nettlefold, of Birmingham, at a Conference last December in London on housing, proper town planning would tend to restrain land speculation, and by restricting the number

of houses put upon an acre of land, its value would be reduced.

The suggestions of Mr. Brodie and Mr. Hooley *re* road requirements of the present day are certainly valuable and practicable.

I can quite believe that a State Highway Department would be advantageous in many ways to facilitate the bringing up of the main roads of the country to the modern requirements of the traffic of self-propelled vehicles, especially in conjunction with greater Parliamentary powers given to local and road authorities, but (with the exception of the making of any new trunk roads) the widening and improved maintenance of roads should, I venture to suggest, be retained by the respective county, borough, or other local road authorities on the lines of local government generally, which is so popular in the present day. Road improvements should, I think, be assisted by State contributions in a manner commensurate with the general through traffic of the country, and which might be arranged on equitable terms, as the result of an inquiry and consideration by a Central Highway Department.

It must be admitted it is quite time that the highways of our country were constructed in a manner more suitable to the altered conditions of modern traffic.

No useful purpose can be served by abusing the motorists of the present day, a great number of whom have borne the burden of the heavy cost of the development of the motor industry of our country by the high prices they have paid for their cars, and the heavy cost of maintenance during the more or less experimental period of the development of a system of locomotion, which is coming into use at an enormous rate.

In dry weather, especially in some parts of the country, it is absolutely impossible for the most considerate driver to avoid causing inconvenience from dust to all users of roads, and from which motorists themselves also suffer very considerably.

The chief difficulty that local authorities and their surveyors have to face is undoubtedly the first outlay; but the annual cost of the maintenance of a road surface, which will minimise dust, mud, noise, and other inconvenience, having regard to its much longer life would, in my opinion, not be so very much greater than the annual cost of the frequent coating, scraping, etc., of the present macadamised roads. But whatever this extra cost

may be, the owners of motor-cars, and of the vast numbers of motor trade vehicles which are rapidly replacing horse haulage, will be perfectly willing to bear their fair share of the financial burden.

It has occurred to me that with such a conference as this over which you, Mr. President, have the honour to preside—a conference on the laying out of towns, and road requirements—if we go away and do nothing beyond simply talk in this room we shall have done nothing at all. The practical outcome of this conference is to pass a resolution of some sort, expressing our opinion and giving some practical effect to our views. I therefore take the liberty to propose the following resolution on behalf of the Corporation of Leicester. It is as follows: "That the Council be empowered to prepare and present to the President of the Local Government Board a memorial in favour of a Bill being introduced into Parliament to enable local authorities to regulate and control the planning of main thoroughfares and building areas, and to prescribe the number of houses to be erected on an acre of ground; also to give power to local authorities, with the sanction of the Local Government Board, to acquire land for open spaces, and to facilitate an improved development of their respective building areas."

Mr. ALDERMAN WILSON (Manchester): I rise for the purpose of seconding the resolution moved by our friend from Leicester. It exactly fits in with the idea of the Building and Improvement Committee of the City of Manchester. In fact, we have spent a considerable time in, possibly, the last two years in trying to amend the building bye-laws and bring them up to a greater state of perfection. These building bye-laws have been submitted to the Local Government Board, and they have rested there for a considerable time. We received them again last week very much mutilated and with certain matters struck out, and we hardly knew they were our bye-laws. However the matter has to come before the Corporation again. No doubt we shall be having an interview with the Local Government Board to see if we can get something much better than we have obtained at present. Our idea is in these building bye-laws to give people more space. In fact, we suggest giving them 200 yards to each cottage. We now have a minimum size of streets 12 yards as regards pavement, with a 2 yards set back, so that from building to building would be 16 yards as against 12 yards

as at present. Main streets to be not less than 18 yards. Back streets or passages to be at least 3 yards, and must communicate with main road or main street every 50 yards in length, this cross street to be 4 yards at least. As regards secondary roads and main roads, the difficulty we find is getting other local authorities to co-operate with us in the continuity of these main roads. For instance, if you make a new road—and we have made several lately—18 yards wide, you very soon come (in Manchester) to another authority, and that authority may not be wishful to continue that road as we should like to see it continue. I think legislation should move in the direction of trying to get powers in that respect—greater continuity of main roads from town to town and town to village, and so on.

Mr. W. J. ROBINSON: I approve of the idea of this resolution, and I want to ask that an addition might be made to it, namely that the Local Government Board for Ireland might be requested to exercise the same powers, so that the benefit that would accrue to this country might also apply to Ireland. I should like to move that.

Mr. R. H. DORMAN: I will second that.

Mr. MAWBEY: I shall be pleased for that to be added.

The PRESIDENT: I do not propose to put this at the present time. I think it would probably be a more convenient course to do so at the end of the discussion.

Mr. A. M. FOWLER: In Leeds, in 1866, we widened Boar Lane, a main artery, from 21 feet to 60 feet, and we did not only do that, but we took power to take land beyond the 60 feet—something like 50 feet—so that we could re-sell. What was the result? Land that was worth about 3*l.* to 4*l.* per yard was sold for 60*l.* per yard, and so recouped to a large extent the expense the Corporation had been at in widening the street. But it did not rest there, we regulated to some extent the quality of the buildings that should be put up, and in doing so, of course, we raised the rateable value of the property in the particular township to a very large extent, and the consequence was that after all these large improvements, the township was not called upon to pay one penny extra rate. I question whether there is any other example in the country like it. I mention these facts to show that corporations should always seek to take a larger quantity of ground than they really require.

Mr. F. J. Edge: What I am about to say may be perhaps looked upon as rank heresy in a meeting consisting of municipal representatives, and perhaps you will pardon me for the reason that I am no longer a municipal engineer. We have heard a great deal about the powers which municipal corporations hope to have. I rather think municipal corporations bring a good deal of trouble upon themselves, owing to the fact that they are rather like our friends the Dutch, "in giving too little and asking too much." We have discussed the question of laying out new estates. There is no doubt in the world that new estates are often laid out to the very great disadvantage of the public. But you must consider the private owner. He naturally wishes to lay out the estate to the best advantage to himself, and the proper thing is, if the public want the laying out of estates to be satisfactory from their point of view, they must pay the difference. Liverpool have recognised that. If they want a wider street for public purposes, the public must pay for the widened street, leaving the private owner to make the streets as wide only as is necessary for local traffic and public health, and paying the owner compensation for any extra width required. The municipality will not get their improvements out of the pockets of the private owner. The consequence being improvements are put on the backs of the municipality, and the private owner is going to get some advantage out of it. With increase of traffic in later years, widened streets become necessary, which if not anticipated would necessitate improvements being carried out at enormous cost. Mr. Brodie has told you about the cost of land in Liverpool. In Newcastle land has changed hands at as much as 200*l.* per yard, and 150*l.* and 180*l.* in the best business streets. That is the price of land in Newcastle, and we can imagine what that means if it comes to widening streets. One great difficulty was pointed out by the President, where you have small estates. Mr. Mawbey has told us what they do to arrange matters between themselves and adjoining estates, so that the adjoining owner is not going to benefit from the streets we are laying out without paying his proportion of that benefit. I am afraid it is only natural, only human nature, that he should wish to get the benefit. The corporation should have power to see that estates are laid out for mutual benefit, and that can only be done by corporations having powers for

compensating owners for any losses which they may be put to by reason of public requirements. As to trunk roads between various towns, some of our county surveyors seem very jealous of State control. In some of our Crown Colonies there is State control of main roads, and probably there are no better roads in the world than in the Crown Colonies where there is State control. There are district roads as well, which are not under State control. I wonder what was thought at the time when wheeled vehicles were first introduced. What an outcry there must have been. "Surely we are not going to be put to the expense of providing roads for these wretched wheeled vehicles? Why do we not continue in the way we have been doing? Let them make their wheels suit our roads." It is the same outcry now with regard to any method of self-propelled traffic. The public say, "We cannot provide roads for these sort of things; they must do away with them." It is merely a question of the good of the general public again.

Mr. W. HARPUR: I think the time has come when there should be some improved legislation to enable local authorities to make better provision for the development of their surrounding districts, and for the improvement of roads, as it affects themselves in the matter of laying out new districts, and in securing that new roads and streets communicate in a proper manner one with the other. I think my town of Cardiff was the first town to get special legislation to enable us to insist upon new streets being connected up in some direction or other with existing streets in adjacent neighbourhoods. We obtained in 1894 special powers of that kind, and since then they have also secured similar powers at Leicester and in other towns. Cardiff also was the first town to get an improvement in the matter of the width of streets under the model bye-laws. After a good deal of argument with the Local Government Board, and a special visit from one of the officials, we were granted a bye-law requiring that main trunk roads should be of greater width than those stipulated in the ordinary bye-laws. I do not think in the development of private estates the local authority should be called upon to pay the piper. Land is often immensely increased in value, not from anything which the landowner has done, but simply from the incident that it happens to be in an adjoining neighbourhood to a town. Mr. Edge says public

authorities want to get road widenings at the public expense. I think the boot is on the other leg; private owners are constantly fighting to get something out of the public authority. And not only do they want to, but they succeed in getting it, I think, in many instances very wrongly. I think it is time legislation enabled us to settle what the landowner is fairly and reasonably entitled to, and that he should not be in a position, as he is now, in many instances, of enforcing the utmost penny, whether he is morally entitled to it or not.

Mr. H. GILBERT WHYATT: Mr. Harpur has told you the result some years ago with regard to negotiations with the Local Government Board, but he has not told you how they tried to get a nice wide road there, whereupon the Local Government Board said they had no powers to enforce this wide road. The Corporation then tried to pay for the cost of the extra width, and the Local Government Board said, "No; it is a private street, and at present you have no power to expend Corporation money upon the widening of a private street"; and so they were debarred. I find the same difficulty in trying to get landowners to lay out their estates so as to fit adjoining estates. Perhaps nine-tenths of my town of Grimsby are owned by six different owners, and practically the whole town is leasehold. Each man lays out his estate step by step, until he gets near the boundary, and then he stops and proceeds in another direction. When he gets the whole of his estate practically laid out, he has no objection at all to allow access to adjoining estates through his own for a small consideration. Having leased the whole of his land, he has nothing more to lose, and he allows the next owner to come through. I quite agree that there should be some greater powers given to local authorities to insist upon these connections being made. I notice a map of an avenue on the wall. We are now trying to negotiate for one something like "Edge Lane Drive," but 72 feet wide instead of 60. It will be about $1\frac{1}{4}$ mile in length, and will be a splendid walk for the inhabitants of the town, if we can only manage to get it through. The owner says, "You want three acres of my land. It is front building land, and you will have to pay me 20*l.* an acre for it, at 28 years' purchase." We say, "No, it is back land; we want simply to push your frontage further back. We give you a better street, and you had better charge us agricultural value"; and the matter still

stands. We try to impress upon him that he is simply giving us a bit of land from the back of the estate, and he is trying to impress upon us that we are taking from him the very best piece of all, that is worth more than all the rest of the land put together. As regards tarred macadam, it has been *taboo* in my town for twenty years. About twenty years ago it was begun, but a certain alderman was driving in a trap, when the horse came down, threw him out, broke his nose, and no more tar macadam. I do not know whether providentially or not, but he died about eighteen months ago. In the following month I began the reconstruction of a street, using tarred macadam, and the economist of the Council raised the matter at the next Highways Committee as a waste of money—an absolute waste of money—but he was the only one, and he could not get a seconder! The Committee said, "Go on with some more," and I am doing so. I have not been able to make tarred macadam out of basalt. I do not use granite at all. There is only Belgian within reasonable reach, and that is far inferior to Rhenish basalt. I have tried tarred macadam made with basalt, but whether owing to some defect in boiling the tar, or what is the reason I cannot tell, it is a failure. With slag it is a great success. I am trying it in some side streets. I simply scarify the present surface, which is slag and not basalt, put a little new slag on to bring up the contour, and sprinkle tar upon it with watering-cans, with about half an inch fine tarred slag on that. It is a great success, and costs about 2*s*. 1*d*. or 2*s*. 1½*d*. per square yard. In my opinion, coarse material should not be put on the top, or water will be bound to get into the interstices and make it a failure.

Mr. T. S. Picton: I wish to add my testimony to that of Mr. Price about tar macadam roads. We in Eccles have twenty-two tar macadam roads; eleven streets are *cul de sac* streets. Five streets have had to be recoated with 1½-inch stone and a topping of ¼-inch stone at a cost of 2*s*. 5*d*. per square yard after a wear of only four or five years. The cause for this could not be ascertained, but most probably it was owing to the stone not being sufficiently dry when the tar was put on. One street has simply had to be retarred at a cost of 7¾*d*. per square yard. Some of the other streets I made of limestone 2½-inch gauge 3 inches thick, 1½-inch gauge 2 inches thick, and ¾-inch gauge

1 inch thick. Stanley Avenue, a *cul de sac*, was completed in 1895. It has a gradient of 1 in 37·50, and the Committee has not spent a halfpenny on that road. If you were to examine it to-morrow you would see it is in a very good condition now, and I am hoping that road will last three or four years yet without having any repairs put upon it. In connection with a street called Cook Street, I was instructed to send to Lytham for some prepared tar; I did so, and found it answered very well. This street was constructed by Corporation workmen, and was completed in 1900. There are two gradients in the street, 1 in 26, and 1 in 133. The road surface is exceedingly good, and no repairs have been needed. The cost worked out at 3*s.* 6*d.* per square yard exclusive of excavation. Stanley Avenue, above referred to, was constructed by contract at 5*s.* per square yard. I am convinced that with streets where you get a heavy through traffic tar macadam is not quite suitable. The road called "The Park," was completed in 1897. It has a gradient of 1 in 141, the foundation of which was made as above, and with tarred stone also as above. The contract cost including foundation was 4*s.* 1*d.* and 1*s.* 3*d.* This road was recoated at a cost of 2*s.* 3½*d.* per square yard in the autumn of 1901 and worked out at nearly 5*d.* per square yard per annum, which is rather an excessive cost for these streets. We have recently done some other streets, one, Mayfield Road having a gradient of 1 in 32·73, and another road with a gradient of 1 in 45·84. We got this tarred stone from Buxton. In Eccles we have approved of the tarred macadam streets being made of limestone, as I am convinced that that material is suitable for streets with light traffic. We are also using the tarred limestone prepared by the Val de Travers Company. These streets have been laid about three years and are in good condition to-day. I think that tarred macadam will no doubt solve the problem of dustless roads if properly constructed. It is most important that tar macadam streets should be well rolled. I was at Brighton two years ago and saw Madeira Road which was then just completed. I thought then that the interstices of that road were too open and that water would get in and the road disintegrate. In connection with the laying-out of towns, etc., there is a street in the town of Eccles—Ellesmere Street—440 yards long and is only intersected, on one side, by two short passages 12 feet in width. The Corporation in 1901 got

a clause in their private Bill that no front street should be approved without an intersecting street of the same width at a distance of 150 yards. Estate owners and builders have now to conform to that clause of the Act.

Mr. F. MILTON HARVEY (Gorleston): There is a great difficulty to face in connection with the future planning of towns. If only Wren's plan for the building of London had been carried out what a glorious city it would be, a city unequalled for grandeur as it is at present for size. The neighbourhood of the Arc de Triomphe in Paris, with its magnificent roads radiating from one spot, is an impressive sight and an instance of a finely thought out idea. What is true of our cities is equally of our villages. The selfish development by which every owner makes a point of getting the largest number of houses on the smallest possible area of land should be stopped. We should do well to follow the example of Washington who, in planning the great city named after him, sent a Commission all over Europe to obtain the best plans for its development. In later years the citizens of a town designed on these lines would be grateful to those who inflicted upon them the expenditure which resulted in the building up of such a fine city.

Mr. EDWARD R. PICKMERE (Town Clerk of Liverpool): I have been very much concerned recently in this very question which we are now discussing. I regret very much Mr. Nettlefold of Birmingham could not be here to-day, to lay the views of the Municipal Corporations' Association before you. That Association has taken the matter up very warmly, and on the question of town-planning formed a sub-committee of which I had the honour of being a member, and of which Mr. Nettlefold was chairman. After many meetings of the sub-committee, considerable discussion, and a great deal of information obtained upon the subject, we ultimately came to the conclusion that it was scarcely possible to expect to get a measure through Parliament which would authorise town councils to lay out the property or land of other people. The difficulty which seemed to surround the subject was that we could scarcely expect we should be enabled to tell the property owner how he could best lay out his land, and to make him lay it out in such a way as the corporations thought he ought to do. That was the view which I myself took in the first instance with Mr. Nettlefold;

but after a good deal of discussion and going through the difficulties and considering, then we came to the conclusion that the best way out of the difficulty would be to insist on having a requirement by Act of Parliament that the owners should submit their own plans in the first instance. We ultimately drafted a scheme for an Act which I shall be pleased if engineers would see, and which no doubt they will ultimately see, through the Association Proceedings. The idea really formulated at last was that all owners should be compelled to submit their full plans of the estates which they proposed to lay out, showing all the roads and the widths and directions of roads in addition to the position of the houses it was proposed to build. The idea is that the plans should be fully considered by the authority, who should have power to require that the roads shown on the plans should be made of the width and the material, and in the direction and position which the authority should ultimately decide upon. It was thought that by that means the local authority would be able to get the property owners to agree to a proper method of laying out their estates; that is to say, that the owners would initiate but the local authority would ultimately decide. Then the further question to be raised was the question of the number of houses in the area. It was thought also that that might be obtained in a similar manner by requiring that only a certain number of houses per acre should be permitted upon the land, and by having very stringent bye-laws that there should be proper air-spaces both back and front of the houses, a matter I am glad to say the Corporation of Liverpool is now taking up for consideration. Other subjects—the question of taking land from property owners which is required for open spaces, and the width of streets, were also carefully considered. If the local authority had power to require property owners to make the width of streets such as the local authority laid down, that would get over the difficulty of having to acquire land or pay compensation to owners for land thrown into the streets. There are other questions—squares and open spaces—which would have to be considered. It was thought owners should be required to sell such land to the local authority as necessary for that purpose. It is not quite agreed, I may say, that the width of the street should be laid down to the absolute requirement of the local authority without compensation, but a clause to that

effect was after discussion ultimately adopted. And there are two or three towns in England which have those powers, and as they exercise them with all due care and consideration for the owners and their lessees, there does not seem to be any reason why we should not ask for these powers to be made general. My personal feeling is that we must not ask for too much. If we ask for too much we shall get the bill thrown out altogether. My opinion is, we cannot expect that local authorities shall have power to order a property owner how to deal with his estate and take from him as much land as the local authority may require for streets and open spaces without some compensation. If we were beginning afresh in England to make new towns such as the Garden City, there is no doubt that local authorities should have very full powers, and we should not have our towns as they are now laid out. We shall be asking too much from Parliament if we take the very drastic method which I gather has been proposed. I thought you would like to know the views which the Council of the Municipal Corporation Association arrived at upon the question after very careful consideration.

Mr. W. B. Purser: It seems to me that in an Association of this sort one of the chief topics of discussion at the present time must be the construction and maintenance of roads. Hearing the speech of Mr. Hooley, it occurred to me that it might appear that we were treating the opinion of others—who are trying in their own way to effect an improvement in roads—with some want of respect. I refer more especially to the Roads Improvement Association. I observe that upon the Council we have a delegate to that Association, and I think we should give him a little guidance as to the procedure he should take with reference to that organisation. I believe if we devoted our attention to getting our Association into sympathy with them, instead of treating their efforts with a certain amount of suspicion, we should be doing a great deal of good to this country and to both associations. I venture to think that the recent dust-trials would not have taken place without the help of the Roads Improvement Association. Our Association is not in a position to undertake costly experiments at its own expense, and therefore I think we should welcome any help we can get from outside associations, who have the same object that we have in view, namely, the excellence of the roads, and

I think we should ask Mr. Wakelam to say, if he would, that we welcome their efforts and are prepared to assist them. With regard to Mr. Hooley's remarks as to the cost of roads, I was struck with the remark that five miles of tar macadam cost him 8,194*l*. That is an outside figure as far as my experience goes on outside roads. We can make a very good mile with 900 tons of granite which, at a cost of 15*s*. per ton, works out at something between 3000*l*. and 4000*l*. for 5 miles. Why Mr. Hooley goes to 8000*l*. I am at a loss to understand. The increase should be explained to us. It should not go forth as our opinion that an ordinary road should cost 8000*l*. for five miles. I was also much struck with the information on tar-washing, where he said it was such a tremendous nuisance in Nottinghamshire. I have tar-painted a great length of the Great North Road, and I must say it has given the greatest satisfaction. I would suggest that we should exchange our views on that matter, because it seems to me tar-washing is one of the best palliatives of the time, if it is done in a proper manner. If any surveyor has any idea of tar-washing his roads he should do so early in summer. If he does it in winter he will have a mess if it becomes frosty. The cost of tar is from 2*d*. to 3*d*. per gallon, and at that price the cost of painting is about 1*d*. per sup. yard done by hand. Tarred granite has been put down over and over again by municipal engineers, and it has been a success. I believe in this county of Lancashire a mile of granite macadam is now being laid, and I put down some tar macadam comprised of quartzite some six years ago with great success in Sussex, and I am told it is in splendid condition now. I agree with Mr. Price that slag is an excellent material. I have used it on several occasions for tar macadam with ordinary gas tar and distilled gas tar; but I believe tar macadam can be made with almost anything if proper care is exercised in mixing.

Mr. J. H. NORRIS: I represent a small borough, and I should like to say I think the necessity for some legislation to enable local authorities to deal with the laying out of building estates is quite as necessary for a small town as a big one. I believe there will be very few men—officials of corporations—present here to-day, who have not had experience of the laying out of estates by private owners, certainly as an exhibition of the way not to do it. In my own town we have had a great many building estates laid out, none of them working in one

with the other, and a great deal of public inconvenience is the result. The only advantage that accrues is advantage to the property owner, who makes as much as possible out of speculation in developing his land. The County Surveyor of Middlesex has told us how Middlesex is developing into one great town. The same thing is happening on the other side of the Thames, in Surrey, and a great deal of money will have to be spent some day in consequence. Much could be saved if legislation were in force to-day giving more control to the local authorities. With regard to the other question, last year and this year I tar-washed a considerable length of the Portsmouth main road, getting almost equally good results from quartzite, basalt, and granite, and I think it will be an entire success. I put nothing on the surface after the tar is laid, but let it sink into the material of the road. The result has been that we have had absolutely no nuisance in the winter with mud, although in some cases we put two coats of tar upon the surface. Two coats cost 1*d.* per square yard.

Mr. T. R. Smith: There is another important point—the question of slipperiness where you have tar macadam in a town street. I have had some little experience in tar macadam. I have been making it for the last fourteen years, and with regard to the materials I have used, I always consider slag, if it be well selected, gives very good results. At the same time, if you use bad slag you are liable to failure. With regard to the special point of slipperiness, I had several years ago to repair a street with a gradient of 1 in 40, and it was done in tar macadam. For a considerable time it had been very slippery, owing to the fine top with which it was finished. I suggested, instead of finishing it with any fine material, we should make it of broken slag of large gauge at the top, and also that we should try to use as little tar as possible. The result was that we improved it materially. We finished it in that way with inch and a half material, and obtained a very good surface, almost purely a surface of stone, which gives a much better grip to the horses' feet than a fine surface where much of the material is tar. The street when washed shows little black veins of tar jointing between the individual stones, and is not nearly so slippery as a street finished with a fine surface. If such streets were periodically washed and kept as clean as posssible, I think it would go a long way towards getting rid of the slipperiness

which seems to some extent inseparable from smooth surfaces. We are about to do a number of other streets, and we intend to do them on these lines. In one street we propose to use granite, and I do not see that we need fear any failure if we use granite with a good rough surface. I do not think very much of the question of the absorption of tar into the material. If the material is soft enough to appreciably suck in the coating of tar it must be soft indeed. A point raised by Mr. Price is one that deserves a good deal of attention—that is the matter of boiling tar. I have had a very unhappy experience in that. For some years we had always done our own work, and then we had a contractor, and we had the tar exuding into the water channels and being carried into houses and business premises; it was very objectionable and we had serious complaints. I had to tell him at his own cost he would have to cut out channels alongside the water channels and fill in with dry material to absorb the tar, and after that retop the streets at his own cost. It was no good for me to tell him, he did not boil the material enough. I think his men had been accustomed to use tars in regard to which much boiling was not necessary. In our own work we get the tar direct from the gas company. We boil it until bubbles cease to rise, and knowing that water and the lighter oils have then been expelled we allow no further mixture to be put into it. I believe if care of that sort be taken, and not too much material used, there is no fear of misfortune.

Mr. A. Gladwell: I quite agree with the last speaker as to the impregnation of the oils of tar into the pores of the structure of whatever material is used. Impregnation of the material by the lighter oils argues to my mind that the material used, whatever it is, is not satisfactory for road purposes. I have made some experiments in a certain direction and, having that view, have endeavoured to obtain a bituminous material which, as against impregnation, would have a strong surface cohesion. That has been done, and I am satisfied by using such a bituminous material, and using granite of good quality, I produce a satisfactory road surface. The result, to my mind, is much superior to the ordinary slag, which I am afraid I can never quite consider as an ideal road-making material. I think this is important because, if we can use granite in conjunction with a bituminous binder as a road

material there is plenty of room for both granite and slag, but if you can only use slag in conjunction with a bituminous matrix, the deposits of granite, quartzite, basalts, and other road materials, become absolutely useless if they are not available for use with tar. I think they are available, and that as perfectly satisfactory results can be got from the use of tarred granite as from any other materials. With regard to the question of the development of towns and town planning, I quite agree that some larger powers are required to enable local authorities to satisfactorily deal with this question. I do not think there is much danger of this or any other Government giving us too many powers, so let us ask for as much as possible. We shall never get as much power for the development of building estates and the development and extension of towns as they have in Germany. But we may obtain, by hard pegging away at the subject, something far more satisfactory than we have at present. At the present time local authorities are virtually helpless with respect to this great question, and I hope the efforts of those engaged in this connection in forwarding the interests of local authorities, and the interests of communities generally, will meet with every success.

Mr. J. S. Brodie: With regard to the subject of tar macadam introduced by Mr. Wike, I have had to make tar-macadam roads for the last twenty years, and perhaps, having such a long experience, I am a little prejudiced in their favour. I must say of the tar-macadam roads I made twenty years ago from blast-furnace slag, they were very successful. One has, of course, successes and failures. I will not say all my roads have given me satisfaction, but the cause of any failures has generally been careless workmen or defective material, or something quite apart from the principle of mixing slag or limestone with tar for securing a good impervious road. During the last four or five years we have at Blackpool adopted a policy with regard to our roads—a policy which involved doing away with all ordinary macadam roads and going steadily in for impervious roadways. If you lay down a mixture of soft stone and fine "blinding" there will be dust and other inconveniences, but I think if you lay down first of all an impervious road surface these nuisances will never arise in any formidable shape. At Blackpool, except for the sand carried up from the foreshore by the feet of pedestrians,

our roads give off practically no dust because our main streets there—and I hope before long all our streets will be so—are impervious, that is to say rain does not penetrate into them so as to break them up. There is one point in my judgment which requires very careful treatment indeed with regard to tar macadam. That is the point of getting good tar. It is not so much, in my view, a question of using undistilled tar or distilled tar, as to be able to get good tar and not bad, as most of you probably know. Then there is the point of getting your material good, whether slag or limestone, and there are several varieties of limestone not suitable for tar-macadam road making at all. And as for granites: there are some granites not suitable for making into tar macadam. Unless these things are considered carefully, and great care taken to provide suitable materials and good workmanship, unless you have fairly intelligent men to carry out your instructions, tar macadam will probably be a failure; but with these things taken together, in my experience, you get the best value for your money in tar-macadam roads of any other description of road we know of at present. I should like to say one or two words upon the question of planning of town suburbs. That is a question in which I am very much interested. I may say at Blackpool we have a large number of small freeholders, whose sole idea is to put as much property as they can on an acre. The sole idea is to cram as much property into the smallest possible area, and we as a municipality are practically helpless in the matter, with all the powers we have won either from the Local Government Board or Parliament. I had the pleasure some months ago of attending a meeting of the Municipal Corporations Association, in which Mr. Nettlefold laid down his views on the matter. I entirely agree with the views he expressed there. It seems to me that to lay out our roads and buildings in the way in which they are now often laid out is to lay up a heritage of insanitation in the future which is nothing short of madness. We are all met with the cry that we are coming to be Socialists, and that we are going to take a man's property from him, and that he is not going to have any say whatever in the development of his own land. Nothing of the sort. I think any owner of property who really studies the matter will agree that we are better able to lay out an estate as a whole—not in detail, but as a whole—

with more roads and communications than any mere layman can do. I think if we pursue that policy of the higher Socialism, so to speak, the policy of sane municipalisation in matters of that kind, obtaining for the greatest number of people the best advantages we can, our successors will thank us for the efforts we have made in their behalf.

MR. A. E. WHITE: The few remarks that I have to make are on the question of town planning. It has been interesting to hear this morning from the Town Clerk of Liverpool something of the proposals of the Association of Municipal Corporations. From the information given by the Town Clerk, and from some information I previously had with reference to the proposals of the Association of Municipal Corporations, it seems that those proposals are intended to deal only with the laying out of individual estates, and that they contain provisions with reference to the width of streets, the materials for the construction of streets, and the purchase of open spaces contiguous to streets intended to be laid out, but they do not contain any provisions whatever with respect to the planning in advance of development schemes for the suburbs of our great cities. It seems to me that the preparation of development schemes is a most important matter. I think it is almost barbarous that the suburbs of a great city such as London should be allowed to grow up, as they are growing up, without any general scheme of development. If the thing had never been done there might be some excuse for our not attempting to do it in England. But, as we know, it has been done practically all over Germany, and I think it is quite time some attempt was made in England to follow somewhat on the same lines. The members of the Association should use what influence they have with the members of the Association of Municipal Corporations, to endeavour to induce them to bring forward something much more complete than apparently it is their intention to bring forward. If a body like the Association of Municipal Corporations brings forward a scheme of this kind as what the municipalities desire, and it goes no further than we are led to believe it does go, it may have the effect of putting back the matter for many years. If the scheme is put forward as what municipalities desire, it will, to my mind, be putting in the hands of our enemies a very strong argument to oppose any more complete scheme which may be brought

forward, as the opponents of any such scheme may point to the proposals of the Association of Municipal Corporations and say, "This is all that the municipalities ask for." It is said that Mr. John Burns has promised a Bill dealing with town planning, and if he brings forward any Bill which can be said to deal with town planning, it seems to me it must go much further than the proposals of the Association of Municipal Corporations, and I think the Association should, at any rate, wait—if there is a prospect of Mr. Burns bringing forward a bill—until we see what that Bill contains. I think it is a most important matter, and I have pleasure in supporting the resolution. I should like to call the attention of those members of the Association who do not know it to the report of the Housing Committee of the city of Birmingham. It is a very complete report, and contains a vast amount of useful information and a number of specimen development plans showing what is being done in Germany. It is published by Percival Jones, Limited, Birmingham, and may be had at the cost of 2*s.* 6*d.*

Mr. C. J. Fox-Allin: I recognise, as every other municipal engineer must do, the great importance of laying out estates with a due regard to the ultimate development of the different neighbourhoods. But our enthusiasm must not override our common sense. I consider that legislature should provide for equitable adjustments between the owners and the local authorities. In endeavouring to do our best for our towns, I am afraid we are apt to think owners should do more than their share. Every surveyor, in making arrangements with owners, should have in front of him a plan indicating the lines on which it is intended to ultimately develop and improve his town or suburb.

Mr. W. N. Blair: From what has been said on the subject of tar macadam, it will be a conclusion in the minds of most of us that the material is one which may be relied upon as securing not only a durable surface, but a surface free from dust, and requiring little attention in the way of water—one which will allow the traffic on our roads, largely of an automobile character, to continue on its way without creating the nuisances which we have had in the past. While it may be within the power of the larger councils and corporations to substitute tar macadam for ordinary macadam without any undue burden upon their rates, it is not in the power of many smaller

and lower-rated authorities to make such substitution on anything like a wholesale scale. It behoves us, therefore, to consider means towards this end. While the end may be eminently desirable, I think the means should also have consideration. Having been present at a conference a few weeks ago at the Institution of Civil Engineers, between road-users and road-makers, we arrived there at pretty well a unanimous consensus of opinion that there should be a contribution from the Imperial funds towards the purposes of which we are now speaking. That was accepted by road-users just as cheerfully as by road-makers, and it only becomes a question how this Imperial fund shall be provided. I think there are no owners of automobile vehicles who will not be quite prepared to pay their quota towards the cost. They largely benefit by these objects we are endeavouring to secure. It makes travelling possible for them without danger, whereas at present danger does undoubtedly exist. Members of our own Association have had experience of that, and of the dust which arises to an extent which would be avoided if we had better surfaces. We are at one also with road-users—I think we are practically at one—with regard to the vexed question of Government control. Many of us road-makers had it in our minds that it was the determined intention of road-users to take the control of the roads out of our hands, and to place them under a Commission to be instituted or constituted by Government. They admitted that such is not now their object, but it must be recognised, if we have an Imperial contribution towards local road-making, that there must be supervision exercised to some extent. That is matter for debate, but the opinion of the conference I have mentioned was that Government supervision should be practically limited to the audit, merely to ascertain that the money contributed from the Imperial funds had been spent strictly on the purposes for which it was contributed, and not used as a substitute for local money which ought to have been spent on the object in question. I think, therefore, we ought to recognise with satisfaction and gratification the attitude of the Roads Improvement Association, who are seeking and striving to get that which we are now discussing—dustless, impervious roads, of good surface and durability. We should not consider ourselves in hostility to them or they to us, and it would be well if we could get an expression of opinion from this meeting

agreeing with the conclusions reached by that conference on the question of Imperial grants; and if that could be brought forward after that which stands before us in the name of Mr. Mawbey, I think it would meet with support. The proposal I have quoted should be put forward in the name of the conference to show that we are all striving towards one end.

Mr. A. T. Davis: I thought Mr. Blair would have finished by moving a resolution similar to one I have pencilled out, and I thought he was taking the ground from under my feet. I think it would be a pity to let this meeting disperse—seeing that we have a number of delegates here from local authorities—without passing a resolution urging the State to come to the aid of the road authorities and help them to bear the additional burden that has been brought about by the self-propelled through traffic. Every one will agree there is additional wear and tear of our roads, and the additional cost brought about by that should not fall upon the localities themselves, but should be borne by the State. I agree with a great deal—nearly all—Mr. Blair has said, and without taking up time I would venture to move: "That in view of the great increase of self-propelled through traffic the State be urgently requested to make special grants to highway authorities towards the additional cost of road maintenance." The resolution, if passed unanimously, would be sent to the proper authorities, and it would, I am sure, assist in bringing about what we so very much desire. The meeting to which Mr. Blair alluded—the conference between road-engineers and road-users—at which I was present, moved a similar resolution, and the County Surveyors' Society, at my request, passed a resolution couched in the same terms, which was sent to the Local Government Board and the County Councils' Association. I do not know whether it was sent to the Municipal Corporations' Association, but I know the County Councils' Association received it with sympathy, and sent up to the Local Government Board a resolution based upon it. If we could bring all possible pressure to bear at the present time upon the Government, it would be very desirable, and therefore I move it.

Mr. W. H. Leete: I second the proposition. I may say my experience of tar macadam and tar washing has been very similar to the experience of Mr. Purser.

Mr. J. T. Eayrs: With regard to the question of town planning, I quite agree with the remarks of Mr. White when he said they did not think that the proposed Bill described by Mr. Pickmere will go far enough. The whole question of town planning, to my mind, depends upon the full and complete development of the district, and the question being dealt with in a broad and comprehensive manner, and not in the limited way in which it is proposed to be treated by the Bill of the Association of Municipal Corporations. They do not look upon it in the broad way in which one must desire to see development. To my mind, I think the towns themselves might do a great deal without legislation at all. I have in view the question as to whether local authorities could not now prepare plans for developing a whole district within certain limits—within reasonable limits of building extensions, at the present time, and indicate the broad lines that such development should take. I do not agree that it should be left entirely to local authorities to determine the direction it should take. I think there should be no difficulty, nor any great obstacle to the formation of a hybrid committee, consisting of members of the local authorities—corporations and urban or rural district councils, as the case may be—the town surveyor also called in to co-operate with them, and professional men engaged as land agents, surveyors, or architects, in the district, and outside experts if thought advisable, in order to secure the adoption of a good plan for the future development of the place. Where one district joined another the co-operation of the two districts could be undertaken. It might be said that in the formation of such a scheme there would be differences of opinion. Probably there would be, but a hybrid committee, such as I suggest, could surely agree upon some definite plan. I do not propose that the whole details of the scheme should be laid down at present, but simply the broad lines—for the main arteries, trunk roads, boulevards, open spaces, and so on. I think that could very readily be done. Although such a scheme or plan might only be the pious opinion of the committee suggested, it would have a very great influence in inducing landowners to fall in with such a scheme, if they could go to the public office where these carefully thought-out plans would be deposited. I think it might induce landowners to fall in with the scheme, and lay out

their land in accordance with such suggestions. It must always be against the landowner at the present time that his laying out his estate is simply limited to what he can get out of it. He cannot see beyond the boundary of his own land, but if he could have put before him such a scheme as would show development, such as has been referred to on the Continent, I think probably the difficulties would not be so great as they are at the present time.

Mr. T. L. DODDS (Mayor of Birkenhead): In my humble judgment local authorities do not possess at the present time sufficient powers in regard to the planning of their towns. Quite lately I have had the privilege of studying somewhat briefly the municipalities of four German towns, and one of the circumstances which impressed itself most strongly on my mind was the far larger powers possessed by German municipalities than any that we have in our possession. The first that recurs to me is the absolute power to take land needed for public improvements. I was told that no difficulties with landowners of any kind had ever arisen in regard to the enlargement and improvement of main thoroughfares. It was a recognised principle that the public good must be the first consideration. That is a condition of things which ought to be extended to this country. Frontagers do invariably get considerable advantage to their property from such improvements as are carried out by the local authority. And I think there ought to be immediate legislation in regard to the control of outlying districts which are likely to be brought into the area of borough boundaries. At the present time these out-districts have absolute power to develop the districts without any reference to the immediate or prospective requirements of the towns in which they would be included. This is a condition of things which should not exist, because, in all our districts, we find buildings going up which are not in accordance with the bye-laws of adjacent towns, and roads are constructed which are too narrow for their prospective use. I have suggested that the German system, which enables local authorities to prescribe conditions of construction outside its own areas, should be the powers possessed by the local authorities of this country. May I say another word, slightly diverse from the point of discussion. That is the absolute need for greater powers of supervision over buildings. Of course the

present powers with regard to sewerage are adequate, and it may be taken that no new town could be constructed or planned without adequate supervision, and an adequate system of sewerage. I think that power should be extended to complete buildings. Plumbing and other things ought to be brought under supervision, with the cost of the supervision imposed upon the property owner. No charge he would be called upon to pay would prove more remunerative than the fact that the whole of his building had been subjected to the direct supervision of the local authority. Another point I would emphasise is the absolute need, now that our main thoroughfares are so largely occupied by motors and trams, for wider back streets or passages. In the town to which I belong we have some alleys and passages under 5 feet in width. That is not a condition of things that is conducive either to the right health or the safety of the infant community, and it might be a subject for your consideration, whether any back street should be of less width than 16 or 18 feet. There is also the question of the disposal of refuse. In my own town we have at the present time some 20,000 ash-pits. No community, large or small, ought to hoard or stock its garbage, and ash-pits should be done away with, and their removal rendered compulsory in all towns.

Mr. G. W. Lacey: With regard to the matter of the improved construction of roads, I am at one with a great many speakers as to tar macadam, but it has been a doubtful point for a considerable time as to the application of tar to granite. At Hereford, last year, I saw a length of tar macadam composed of Clee Hill granite, and I was informed this morning that up to the present it was answering admirably. At Ellesmere Port last year there was laid a considerable length of tar macadam composed of Ceiriog granite from North Wales. There were two stones, quite dissimilar, but both of which were answering for tar-macadam purposes. In making use of granite the question of absorption of tar into the stone has no bearing at all on the cohesion of the stone when laid as tar macadam, for if the tar is of proper consistency it will adhere to the stone if properly dried, and the tarred surfaces of the stones will certainly adhere to each other. There is one point with regard to the economical construction of roadways which has hardly been touched upon—bituminous matrix and dry

macadam. It has been held that a macadam road could be formed by the application of dry chippings, provided sufficient rolling was done to securely fix the stones; if that could be done with dry chippings, it should be a much more easy matter to perform the operation with chippings which have been coated with tar. I have laid down a short length of road, first rolling the macadam dry and then sprinkling on a layer of tarred chippings and rolling in, and finally a second sprinkling of tarred chippings and again rolling, and up to the present time that has answered very well. My intention next is to coat the dry macadam with tarred chippings before rolling, so that the interstices of the stones may become more filled, and then to apply a final dressing and rolling as before described. If we could fill the interstices of the stone and bind it together by some simple process such as described, that would give a surface greatly improved on the old method of construction.

Mr. Mawbey's proposal was then put to the meeting and unanimously agreed to.

Mr. A. T. Davis: I formally move the resolution which is in the hands of the Secretary: "That in view of the great increase of self-propelled through traffic, the State be urgently requested to make special grants to highway authorities towards the additional cost of road maintenance." I may say this, that it is obvious to every one that the cost of even tar painting, which has been mentioned this morning as about 1*d.* per yard, in some instances really means—I am not speaking of district roads—doubling the cost of maintenance. So when we consider the great dust nuisance, it is patent to every one that the cost in some cases will be doubled and trebled. The State, I think, should come to our aid.

Mr. W. H. Leete seconded the motion.

Mr. J. P. Norrington: I wish to point out that if the State gives aid to certain purposes the money comes out of the pockets of the ratepayers generally throughout the Kingdom, and I cannot see that there is any special reason why the people in the country should not bear their proportion of the cost of maintaining the roads as well as those in the towns. Mr. John Burns told us at the meeting at Battersea that the cost of the maintenance of roads in London averaged 1000*l.* per mile per annum. Where is the district in the country that pays anything approaching that sum? If, therefore, the State

gives aid to the maintenance of roads in the country, it will mean that the townsman will contribute towards the cost of roads three or four times as much as the countryman. The countryman uses the roads in the towns, and he never has, or is it suggested that he should, contribute to their upkeep. I do not think that at this late hour of the meeting the resolution proposed should be adopted; it is too important a matter to deal with to-day; moreover it is a political question, and there is much more in it than appears on the surface. I am in favour of all the main roads being properly maintained, but the cost of doing the necessary work would never approach the cost of maintaining the roads in the towns, so that the present arrangements seem to me quite equitable for all parties.

Mr. H. T. Wakelam: I would point out to Mr. Norrington that the townspeople really have the benefit to a very great extent of the country roads. Take the Birmingham and Walsall road. There is a road which carries the traffic between these two towns, which are about seven miles apart, and it is absolutely town traffic. The country people have no benefit from it, and yet the country people have to pay for the upkeep of that road. That alone answers Mr. Norrington at once. I could go on citing other similar cases the whole day, but I do not want to take up time. Mr. Blair mentioned the motion carried by the Roads' Improvement Association the other day with regard to State aid. I am quite sure no one who understands and studies the roads question of this country will have any objection to the motion for "State aid" in connection with the main roads. Mr. Davis points out that even tar washing at one penny per yard practically doubles the cost of maintenance of the urban main roads in the country. I agree with him, having gone into the figures. Mr. Purser made some very pertinent remarks as to the Association sending me as their representative to the Roads Improvement Association with some idea as to the line to be followed. I appreciate Mr. Purser's remarks, but I think I quite understand what this Association requires in connection with the improvement of roads. The Roads Improvement Association changed their ground considerably on the improvement question in connection with the tar-washing tests at the time those tests were going on. When we got to Ascot the other day the Chairman of the Roads Improvement Association

said State control formed no part of their programme, and he repeated it at the conference on highways a fortnight ago. I am quite sure that with the assistance of this motion and that of the County Surveyors' Society, the matter may safely be left in my hands at present, and you may rest assured that I shall endeavour to watch closely the interests of that society and also of this association in connection with the State control proposal.

Mr. BARBER: With reference to Mr. Norrington's grave objection as to some State difficulties, I do not pretend to be in the confidence of the Government, so I cannot say what those difficulties may be. At the same time I would remind Mr. Norrington that persons who live outside London—in Liverpool and elsewhere—pay their rates towards the maintenance of their own parks and open spaces, and, in addition, they pay taxes for the maintenance of certain royal parks in London to which the public have access. To be consistent he should protest against people outside London having to contribute towards the cost of maintaining parks in the metropolis, if he objects to a proposal that the principal main roads of the country should be maintained at the expense of the nation.

The PRESIDENT: I suggest that the resolution be altered so as to read that the Council be empowered to prepare and present a memorial, so that it should not go direct from this meeting.

Mr. DAVIS: I quite agree.

The resolution was amended in the following form and carried:—"That the Council be empowered to prepare and present to the President of the Local Government Board a memorial urging the Government to make special grants to highway authorities towards the additional cost of road maintenance brought about by the great increase in self-propelled through traffic."

ANNUAL MEETING AT LIVERPOOL.

June 20 and 21, 1907.

LIVERPOOL.

By EDWARD R. PICKMERE, M.A., J.P., Town Clerk of Liverpool.

The commercial prosperity of Liverpool is no doubt largely due to the natural advantages derived from its position upon the banks of the river Mersey, but, notwithstanding these advantages, its prosperity could not have been fully secured unless it had been able to call to its assistance from first to last eminent and practical engineers, whose skill and ingenuity have made it possible for the port to be developed to its fullest extent.

The River Mersey was, in the seventeenth century, an apparently insignificant stream, both as regards its length and the volume of water which it carried to the sea.

The Irwell and the Weaver, tributaries of the Mersey, were not navigable until the end of the seventeenth century, so that Liverpool, in the early period of its existence, possessed none of those advantages of water communication with the interior, from which London, Bristol, Lynn, and Hull derived so much of their early wealth. The numerous and extensive water communications with the interior, which Liverpool now possesses, and of which more will be said later, are entirely the result of art and labour, and are of modern and artificial formation.

It is therefore not surprising that during the first four hundred years of its history Liverpool made but little progress as compared with other towns, and its present flourishing condition reflects great credit upon those who so pluckily attacked and conquered the natural disadvantages which stood between them and prosperity.

It may be well at this point to briefly narrate the history of the early charters and the ownership of Liverpool prior to the time it was fully secured to the Corporation.

Previous to the reign of King John, little reliable information can be gleaned about Liverpool. William Baxter, a writer of British Antiquities, has claimed for Liverpool an origin as ancient as that of Chester and other places of noted antiquity.

In the preface to one of his works, under the title of "Glossarium Antiquitatum Britannicarum," he claimed that Liverpool was the true site of a port named Portus Segantiorum, the situation of which has always been a vexed question with antiquaries. It was mentioned by Ptolemy, the geographer of Alexandria, as one of the ports lying between Morecambe Bay and the River Seteia, which river is supposed to be the Dee, although this statement is based on somewhat slender evidence. Baxter's theory is, however, scouted by Camden, and more recently by Baines, Picton, and Professor Ramsay Muir, the Andrew Geddes and John Rankin Professor of Modern History of the University of Liverpool, who has recently published excellent works dealing with the intricate problems connected with early Liverpool. Professor Ramsay Muir says of Liverpool prior to the charter of King John in 1207:—

"Before the end of the eleventh century the history of Liverpool is a blank. There is no means of knowing when or by whom the first settlement was made on the site of the future city; it is not even possible to say from which of the many races who have dwelt in South Lancashire the place got its name, for the name of Liverpool is a puzzle to the etymologists.

"Our earliest information comes from those diligent commissioners whom William the Conqueror sent round the country to discover the extent of the taxable resources, and whose investigations were the basis of Domesday Book. But even they have, strangely, little to tell us. They do not even mention Liverpool by name, and it is only by inference that we gather some notion of what the place was like at this period."

After drawing a word-picture of what Liverpool probably was in that remote period, he proceeds—

"Probably a good part of the livelihood of these serfs consisted of fishing. The Pool was an excellent place for drawing up fishermen's cobles out of reach of the swift currents of the estuary. The Mersey was long famous for the abundance of its

fish, and as late as the end of the seventeenth century salmon-trout were caught in such plenty that they were used to feed the swine."

It is recorded that Earl Roger of Poitou owned among his other numerous possessions, that of the Manor of Liverpool, and to him is credited, by some writers, the making of the Royal Park of Toxteth, and the building of the Castle of Liverpool, although the latter is discredited, and is claimed to have been the work of William de Ferrers at a later period between 1232 and 1237. The most ancient document now in existence, in which Liverpool is mentioned by name, is a deed executed in the reign of Richard I. by John, Earl of Morton, afterwards King John, who was then Lord of the Honour of Lancaster, in which he confirms Henry Fitz Warine in the possession of Liverpool, granted to Warine de Lancaster, the father of Henry Fitz Warine, by Henry II.

There was formerly a belief that Henry I. granted a charter to the Borough of Liverpool, but there is no such charter in existence. A charter purporting to have been granted by Henry I. was forged by James Williamson, Attorney, of Liverpool, in 1800, the original draft of which is in the possession of the Corporation.

The first charter granted to Liverpool was that of King John in 1207—seven hundred years ago—which secured to the inhabitants a commercial freedom not hitherto enjoyed by them.

This charter (or more properly speaking "Letters Patent") was granted "to all our faithful people who have taken burgages in the township of Liverpul that they may have all the liberties and free customs in the township of Liverpul which any free Borough on the Sea has in our land;" but it did not expressly create Liverpool a Borough, which honour was not bestowed until 1229, when, by the charter of King Henry III. dated the 24th March of that year, the question was put beyond doubt.

The date of the creation of the *Port* of Liverpool is not known, but in 1292, in the "Records of Pleas," it is shown that the "port of Liverpool" existed at that time. The pleas referred to concerned "the wreck of the sea in the Port of Liverpool in a certain place called Crosby Schort," and subsequent to that date the term is used repeatedly in ancient documents.

The history of the port, however, forms a separate and no small part of the subject under review, and will be fully dealt with at a later stage in this paper.

Liverpool was undoubtedly a royal borough. After it was created a borough by King Henry III. the town and lordship was held by the succeeding sovereigns until the creation of the Duchy and County Palatine of Lancaster by an Act passed in the 25th year of the reign of Edward III. (1351), then by the Dukes of Lancaster, until the duchy merged in the Crown, on its assumption by Henry Bolingbroke, as King Henry IV., and, from that time, by the sovereign as Duke of Lancaster, until the time of King Charles I., by whom all the rights of the Crown and duchy, in many manors and lordships, including Liverpool, were sold in 1628, with all the rights and appurtenances to the citizens of London, to be held "as fully freely and entirely, and in as ample manner and form, as we or any of our progenitors or ancestors, late Kings or Queens of England, had or enjoyed, or ought to have enjoyed, the premises by these presents before granted or any parcel thereof," but the fee-farm rent of 14*l.* 6*s.* 8*d.* was reserved to the Crown.

In 1635 the citizens sold the town and lordship of Liverpool with all the rights therein conveyed to them, to Richard Lord Molyneux, subject to the fee-farm rent. In the year 1670 Carl Lord Molyneux purchased the fee-farm rent from the Trustees appointed by the Crown and by Parliament to sell such rents, and thus became absolute lord of the fee. About this time disputes and differences arose between the Molyneux family and the Corporation as to their respective rights, and in the year 1672 an agreement was entered into by which the Corporation, who had been lessees under the Molyneuxes from 1557, became the lessees of the town and lordship for the term of 1000 years, at the yearly rent of 30*l.* Under this lease the Corporation held the town and lordship until 1777, when they purchased the reversion for the sum of 2250*l.*

The settlement of the disputes between the Molyneux family and the Corporation, and the giving to the latter of a secure tenure of the town and lordship for the term of 1000 years, were important events in the history of Liverpool, and it was then that the Corporation of that day set to work to develop the property, and, as already stated, it is to a large degree to the energy, skill, and forethought exercised by them that

Liverpool owes its present position. Up to that time the trade and commerce of Liverpool had been insignificant, and all that is known of the state of the harbour is what can be gathered from the record books of the Corporation, which commence in the reign of Edward VI. From these we learn that in the year 1551 (the Corporation then being lessees under Sir William Molyneux, who was the tenant of the Crown) a water-bailiff was appointed to keep order and prevent encroachments and obstructions in the port, that a public warehouse was maintained by the Corporation in which all goods received into the town were stored, and in consideration of which the Corporation received certain dues on goods so stored and called "hallage." In 1561 the Corporation, with the assistance of the inhabitants of the town, formed a new haven in place of the ancient haven, which had been destroyed by a great storm. This work was done by the labour of the inhabitants, every house sending a labourer gratis. In 1611 the quay was improved, and in 1636 a new quay was constructed, and at various dates between this and 1708 rocks and obstructions to the navigation were removed.

This haven and quay appear to have been the only accommodation available at that time for the shipping resorting to the port, and it was fully realised that, to ensure prosperity to the borough, greater attention would have to be paid to the shipping accommodation.

Various plans were considered with a view to forming an artificial canal or a dock in the "Pool," up which the tide flowed into the town. The outer channels and approaches into the harbour were also in a defective condition, and were described by Captain Granville Collins, Hydrographer to the King, as follows:—

"Being at the back of Hyle (Hoyle) Sand, bring the mill and wood one on the other, and run in, keeping close along Hyle Sand, and so into Hyle Lake (Hoylake). Here the great ships that belong to Liverpool put out part of their lading till they are light enough to sail over the flats into Liverpool. There is a channel near Formby to go into Liverpool, when there are three fathoms at low water on the bar; but this place is not buoyed or beaconed and is not known. The ships lie aground before the town of Liverpool. It is bad riding afloat before the town, by reason of the strong tides that run here,

therefore ships ride afloat at the Slyne (Sloyne), where is less tide."

In 1708 the Corporation passed a resolution desiring and empowering the Members of Parliament for the borough "to treat with and agree for some person to come to the town to view the ground and place of the intended dock."

Mr. Thomas Steers, of London, was appointed, and under his direction the "Old Dock" at Liverpool (which occupied the site of the present custom house), was constructed. This was the first dock made in England for mercantile purposes. The Corporation, thoroughly in earnest in their determination to make Liverpool a place of importance, gave the land required for the works, and contributed, in addition, 500*l.* in money. For the purpose of raising the further funds necessary to complete the works, application was made to Parliament, which resulted in the passing of the first Liverpool Dock Act in the eighth year of the reign of Queen Anne (1708). Thus were laid the foundations of the commercial prosperity of what was destined to become the second city in the empire.

It may be convenient to narrate briefly the successful efforts which were made by the Corporation in connection with the construction of the docks and the advancement of the trade of the port during their trusteeship, extending from 1708 to 1857.

By the Act of 1708 referred to, the mayor, aldermen, bailiffs, and common council of the town were appointed trustees for the purposes of the Act. Other Acts were obtained from time to time as the trade of the port increased.

The docks constructed between 1709 and the end of that century were—

The Old Dock, consisting of 4 acres; the Salthouse Dock, of 7 acres; the George's Dock and Basin, 14½ acres; the King's and Queen's Dock, 12½ acres—the sites for each of which were given by the Corporation.

In addition to the gifts of lands, the Corporation gave 500*l.* in 1709, and 1000*l.* in 1785, while other sums were voted from time to time for the purpose of encouraging the development of the port. An active interest was taken in procuring the Act for making the River Weaver navigable, which opened out the salt districts of Cheshire, and in the making of the Sankey Brook navigable from the coal district of St. Helens, which

resulted in the formation of the Sankey Canal, the first navigable canal in England.

The Corporation subscribed towards the expense of making an application to Parliament for an Act to make a canal from the Mersey to the River Trent, through the Potteries, resulting in the importing of clay to the Potteries and the exporting of the goods through Liverpool.

Contributions were also made in aid of the expense of the Act for making the Leeds and Liverpool Canal, which opened out the manufacturing districts of Wigan, Blackburn, Chorley, Bolton, and other towns of Lancashire and Yorkshire. The Corporation also agreed to undertake the expense of a survey by Brindley, the engineer, with a view to the construction of a canal to unite the Bridgewater Canal with the Staffordshire Canal, and the opening up of communication between Manchester and Liverpool, and the Potteries and iron districts of Staffordshire. The Corporation were also instrumental in obtaining an Act to construct a turnpike road from Liverpool to Warrington, thus opening up communication with the main roads leading to London, in addition to which the formation of roads to Preston and the north were encouraged. A site was provided for gunpowder magazines, and other facilities were offered for the convenience of commerce.

Professor Ramsay Muir, referring to the Corporation's enterprise in connection with these undertakings, says:

"They gave their aid also to the accomplishment of other engineering works which helped to overcome that geographical isolation and those defects of communication which had hitherto hampered the growth of Liverpool's trade.

"During the first half of the eighteenth century the main object of the engineers was the deepening of existing water-courses, which in the neighbourhood of Liverpool were so poor as to be useless for purposes of navigation."

It will be seen that the Corporation took no mean view of their duties, either in their corporate or trustee capacity.

During this period the Corporation expended upwards of a million pounds in these objects, and their earlier contributions, out of the corporate purse, may be better appreciated when it is pointed out that the total income of the Corporation in 1703 was only 908*l.*, in 1721 1361*l.*, and in 1734 2338*l.* In order to extricate the Corporation from a condition of insolvency

brought about by their efforts to help forward and improve the trade of the port, it was found necessary to sell the reversionary interest in a considerable portion of their leasehold estates. The sums raised by this means amounted to upwards of 180,000*l.*

The Corporation again, in their corporate capacity, came to the assistance of the merchants and shipowners in 1793, when, in consequence of the French Revolution, a commercial panic was brought about which resulted in a banking house failing. In order to restore confidence the Council passed a resolution to obtain a loan from the Bank of England by bond under the corporate seal. The negotiations with the Bank of England having failed, the Corporation applied to Parliament for a Bill to enable them to issue negotiable notes.

This Bill passed into law, and the Corporation were authorised for a space of two years to issue and pay notes for 100*l.* and for 50*l.* bearing legal interest, and for 10*l.* and 5*l.* without interest, the total sum in circulation not to exceed 300,000*l.* By this means confidence was restored, and solvent persons were enabled to continue their trade. The operations were continued until 1796, when, the panic having subsided, mercantile transactions reverted to their ordinary channels.

In 1775 the Council and merchants formed a joint committee to promote the general interests of commerce, which was called the "Board of Trade," and which performed the functions now undertaken by the Chamber of Commerce.

The Corporation paid this body, in annual votes, between 1775 and 1797, no less a sum than 11,149*l.*, in order to further promote the trade and commerce of the port.

In 1800, although the Corporation were suffering from the pressure of the times, and from the heavy demands made upon them in consequence of the extensive improvements which were being carried out, a resolution was passed, "That in future there be no renewals of the present outstanding leases for lives and years of the ground westward of the Salthouse Dock, Dry Dock, and the passages from thence into George's Dock, called Nova Scotia, or any of them, or any part of them, but that the same be reserved as they shall severally fall in and revert to the Corporation for the more suitable and advantageous use and exercise of those grounds and buildings for commercial purposes in the extension of the dock quays and piers built, or

hereafter to be built, for the improvement of the port of Liverpool."

They also agreed to pay half the expense of a wagon road or railroad, for the conveyance of stone to the south end of the Queen's Dock, the stone to be conveyed thence to boats to such docks or places on the river as might be required. All stone used up to this period in the construction of the docks, which must have been of very considerable value, was given by the Corporation to the Dock Trust without any payment for the same.

The following interesting reference to this stone appears in a Liverpool Guide published in 1799:—

"At the top of Duke Street will be observed the opening to a subterraneous passage that leads to a delf or quarry of considerable extent and depth, from whence stone is procured for the construction of the docks and public edifices. The stones are cut out of the solid rock in such shapes and sizes as the purposes they are adapted to require."

In 1803 a sum of 5000*l.* was contributed to place the port in a secure state of defence. 5639*l.* was expended about the same period in forming the Manchester quay and basin for small craft, trading between Liverpool and Manchester, and other places in the interior of the country, out of the corporate funds.

These contributions appear frequently, and are too numerous to mention, and everything possible appears to have been done to further the interests of the port.

The progress of the trade of the port may be better understood by the following table:—

Year.	Vessels.	Tonnage.	Dock dues.
			£
1757	1,371	—	2,336
1767	1,704	—	3,615
1777	2,361	—	4,610
1797	4,528	—	13,319
1800	4,746	450,060	23,379
1810	6,729	734,391	65,782
1820	7,276	805,033	98,412
1830	11,214	1,411,964	151,359
1840	15,998	2,445,708	178,196
1850	20,457	3,536,337	211,743
1857	22,032	4,645,362	374,295

Under the Dock Act, 51 George III., the Old Dock, the site of which had originally been given by the Corporation, was filled up, and the site vested in the Corporation. In

consideration of receiving this site, the Corporation undertook to lengthen the Queen's Dock at their own cost, the expenditure being 15,163*l.* The Corporation undertook to build a Custom House, Excise Office, Stamp Office, and Post Office on the site of the Old Dock. The Treasury contributed 150,000*l.*, and the Corporation contributed 79,000*l.* and the site valued at 30,000*l.* The Corporation also undertook to keep the building in repair for ten years. The total cost falling on the Corporation amounted to 110,000*l.* The Corporation by this expenditure enriched the Dock Estate to that extent, as the Trustees were authorised by the Dock Act to erect these buildings out of Dock funds.

In 1829 the sum of 30,457*l.* was expended by the Corporation in building a Lighthouse, the only expense which was borne by the Trustees being the lighting of the same, and a nominal rent of 1*l.* as an acknowledgment. The sum of 1600*l.* was paid annually from 1829 for the maintenance of an embankment at Wallasey Leasowes. In 1835 the Corporation gave a valuable piece of land for the improvement of the approaches to the Prince's Basin. Half the cost of dredging the bar, in 1836, was borne by the Corporation, their share amounting to 2282*l.*

In 1842 the Corporation promoted, at their own cost, a Bill for the purpose of establishing a Conservancy Board, and undertook the payment of two-thirds of the salary and expenses of the acting Conservator and others.

The Corporation established an Observatory at a cost of 10,342*l.*

The Corporation, in addition to owning in their Corporate capacity the Docks at Birkenhead, also owned a considerable quantity of land in Birkenhead fronting the river. In order to advance the shipbuilding operations, the Corporation, on representation being made by Mr. John Laird, Messrs. Clover and Royle, and Messrs. Clayton and McKiverigan, Shipbuilders, advanced 70,000*l.* for the purpose of constructing ship yards and graving docks, with suitable workshops, on this land.

The works completed in 1857 were as follows:—

From 1709 *to* 1811.—During this period were constructed the Old Dock, the Old Dock Gut, Dry Dock, Salthouse Dock, George's Dock and Passage, George's Basin, George's Ferry Basin, King's Dock and Queen's Basin, affording a water area of 30 acres and 4500 lineal yards of quay.

From 1811 *to* 1825.—The Queen's Dock was constructed, and also the Union Dock and Brunswick Basin (now Coburg Dock), and Prince's Dock and Basin, the Seacombe Ferry Basin and the South Ferry Basin. The water area at this period amounted to 58¾ acres, and quayage to 9500 lineal yards.

From 1825 *to* 1835.—The George's Dock was enlarged, the Old Dock was filled up, and the Clarence, Clarence Half-tide, Trafalgar, Victoria and Waterloo Docks, together with the Brunswick Dock and its Half-tide Basin and Graving Docks, and the Clarence Graving Docks were constructed. The water area was by these works increased to 100½ acres, and the quays to 15,500 lineal yards.

From 1835 *to* 1851.—The King's Dock was rebuilt, the Brunswick Basin altered into a Wet Dock (Coburg), the Toxteth Dock was rebuilt, the Salthouse Dock was altered, the Harrington Dock and Basin, and the land connected therewith purchased. The Albert Dock and its warehouses were constructed, the Old Dock Gut was altered into the Canning Half-tide Basin, and the Salisbury, Collingwood, Stanley, Nelson, Bramley Moore, Wellington, Wellington Half-tide, Sandon, Sandon Basin, Sandon Graving, and Huskisson Dock were constructed. The water area at this period had increased to 171 acres, and the quays to 24,000 lineal yards. The area of warehouses was at this time 22,000 square yards, and a double line of railway had been laid along the whole length of the Docks.

From 1851 *to* 1857.—The Huskisson Dock and the Wapping Dock and Basin, the Stanley Warehouses, and those at the Wapping Dock were constructed, the Queen's Basin was converted into a Wet Dock, the Queen's Dock was deepened and rebuilt, and the High Level Coal Railway at Bramley Moore and Wellington Docks was built, and connections with the London and North-Western and the Lancashire and Yorkshire Railways and the lines of the Dock Railway were formed. At this period the water area amounted to 208½ acres, and the quays to 27,800 lineal yards, while the warehouses occupied 41,000 square yards. The length of Graving Docks on the Estate was 1 mile 780 yards, while the area of the Liverpool Dock Estate amounted to 816½ acres.

The works then in construction were a Dock to the north of the Huskisson Dock, with an area of 17½ acres and quayage

of 1336 lineal yards, and an entrance lock and gates 100 feet in width.

Between 1709, when the first dock was constructed, and 1857, the concluding year of the Corporation's Trusteeship, the population of Liverpool had increased from about 10,000 to 400,000.

From 1857 to the present time great and rapid strides have been made under the management of the Mersey Dock and Harbour Board in perfecting the Dock System of Liverpool, which, to-day, can be claimed as the finest in the world.

From a descriptive account of the Dock Estate prepared by Mr. Miles Kirk Burton, the General Manager and Secretary of the Dock Board, it is shown that from the Herculaneum Dock at the south end to the Hornby Dock at the north the river is fronted for a length of about 7¼ miles by a system of docks and basins (having a water area 558 acres and a lineal quayage of over 35 miles) of every imaginable type and variety, from the gigantic accommodation necessary for the ever-increasing size of the Atlantic liners to the lesser requirements of the small coasters.

There are sixty-three wet docks, the most notable being those constructed for the use of the large Atlantic liners, which speak eloquently of the masterly manner in which the exigencies of the trade of the port have been met.

Within the confines of this paper justice cannot be fully done to this great undertaking, and but a passing reference can be made to the many facilities which now exist for the expeditious handling of the vessels arriving in Liverpool. It is said that the dock engineers' wages bill averages 10,000*l.* to 11,000*l.* sterling per week, and the number of men employed has been upwards of 8000 at a time, exclusive of payments to contractors and the men employed by them.

The following quotation from Mr. Burton's account relating to the despatch given to the *Lake Champlain* illustrates the expeditious manner in which the up-to-date system enables vessels to be dealt with:—

"The vessel arrived in Liverpool on a certain Sunday, and in forty-eight hours had discharged 12,000 tons measurement of cargo, and sailed again the following Wednesday morning with 2000 tons of coal and cargo, and a large contingent of troops. The case of the *Lake Champlain* must not be taken as an

exceptional one, as it is a common thing for 1000 tons and upwards to be discharged per working day of nine hours."

The tobacco warehouse of the Board at the Stanley Dock is the finest warehouse in the world. The building consists of a vault, quay, and twelve fire-proof upper floors, the latter specially constructed for the storage of tobacco, which permits of the storing of 60,000 casks in single tier, *i.e.* without piling. The quay floor is used for the landing of cargoes, and the basement for the storage of general goods. Some idea of the magnitude of the warehouse may be gathered from the fact that 27,000,000 bricks and about 6000 tons of iron were used in its construction. The warehouse is fitted with hydraulic lifts, hoists, etc., and is lighted by electricity.

The landing-stage, alongside which the large liners are now brought, runs along the river from the Princes Dock for a length of 2478′, provides accommodation for passenger-boats plying between Liverpool and Ireland, the Isle of Man, and other places, and the numerous ferry-boats, where every facility is provided for the expeditious transit and landing of passengers. This forms a contrast with the crude arrangements of the eighteenth century, of which the following is a description:—

"Several large ferry-boats, filled with passengers to the Chester Fair, were hauling out of the old Dock gut along the north wall, the wind blowing fresh from the south-west; when suddenly a very large ship, hitherto unnoticed, was coming upon them, from the river with considerable velocity, and in such a manner and direction, as no human efforts could avert; as the boats were too numerous to be got away, and no time to get the passengers out of the boats upon the quay. In this terrifying situation, as the ship, with a sea-monster's head, as if to aggravate the horror, appeared very near the boats; the cries of distress from the passengers, who seemed but too sensible of their situation, were painful indeed. Too soon the ship, without any decrease of its speed, struck one of the boats in the middle with its stem. The boat, although a strong one, being close to the wall, was instantly shivered to pieces. The shriek of distress now ceased. In a few minutes, however, baskets, hats, fragments of the boat, and immediately after the bodies of the unfortunate people had emerged, and were floating upon the surface of the water."

The tonnage of vessels entering the port in 1906 amounted

to 16,147,856 tons, while the income from rates and dues had increased to 1,305,509*l.*

Nor has municipal Liverpool failed to advance with the times, for, within a comparatively short period, it has been transformed from a small town of 1858 acres, with a few streets, a few houses and mills, and a population of 5700, to a city of 16,619 acres, a population of 739,180, streets representing a mileage of 495 miles, and a rateable value of 4,658,306*l.* It now possesses some of the finest buildings in the country, public institutions to meet the requirements of both rich and poor, and a municipal administration of which the city may be justly proud. Its tramways, with a mileage of 104 miles, is worked by the Corporation, and carries annually no fewer than 122,094,528 passengers, while the electrical undertaking, which is also in the hands of the Corporation, is in a flourishing condition, and a valuable asset to the city's finances.

Its baths, free libraries, reading-rooms, art gallery, museum, and parks are the envy of many towns; while in the matter of the housing of the poor, Liverpool certainly stands in the forefront, and its water supply is admittedly one of the finest in the kingdom, the daily supply representing about 30,000,000 gallons.

Liverpool was created a city in 1880 by a charter of Queen Victoria, and in 1893 the title of "Lord Mayor" was granted by letters patent to the chief magistrate for the time being.

In 1904 the University College obtained from the Crown its charter as a fully organised and independent University.

A Cathedral worthy of the city's importance is now in the course of erection, to take the place of the pro-Cathedral of St. Peter, one of Liverpool's oldest churches, which is rapidly falling into a state of decay.

Liverpool's architecture has been further beautified by the new and handsome offices of the Mersey Docks and Harbour Board, erected on the site of the old George's Dock, which, with other buildings about to be erected there, will present to incoming vessels one of the finest approaches in the world.

The writer regrets that, owing to the limited space of this paper, he has had to confine himself, to a great extent, to the commercial side of the question, and has been unable to deal with many interesting phases of Liverpool's past history, such as the Castle, the Tower, its connection with the Slave Trade,

the American War, the Privateers, King John's wars in Ireland, the Civil Wars, and many others of equal interest, of which much has already been written by local historians.

The formation of the University and the creation of a School of History have, no doubt, been largely instrumental in bringing before students and others, and impressing upon their minds the importance of the historical events in connection with Liverpool, and great praise should be given to Professor Ramsay Muir for the manner in which, through his writings and lectures, he has given to the citizens of Liverpool so much information upon the history of the city. Others are also working in the same direction, and, under the able guidance of Mr. Frank J. Leslie, a committee of ladies and gentlemen is preparing to celebrate, in the early days of August this year, the grant of the first charter by King John in 1207. An effort is being made to illustrate, by means of a stately pageant and other festivities, the principal events in the history of Liverpool from the early period to the present time.

The commemoration of the grant of the charter will be further celebrated by an historical exhibition of objects connected with or illustrative of the annals and industries of Liverpool; the presence on the broad waters of the Mersey of the Channel Fleet, under the command of Admiral Lord Charles Beresford, will be a fitting symbol of the sea-power which safeguards the commerce of the port.

In conclusion, one cannot but be impressed by, and regard with great admiration, the work of the pioneers of this great city of to-day, who, in the face of great engineering difficulties, laid a solid foundation for the public men of the succeeding generations to build up the fame it at present enjoys.

Mr. S. S. Platt moved a hearty vote of thanks to the Author. This was seconded by Mr. W. N. Blair, and carried unanimously.

COMMUNICATED DISCUSSION.

MR. H. GILBERT WHYATT: I would like to ask a few questions on this Paper. The Paper is undeniably interesting, but to Municipal Engineers it might be made more interesting by the addition of a little further information.

It is not generally known that Liverpool possesses enormous estates, but I believe it is also in possession of Parliamentary Powers which enable the Corporation to invest any Borough Fund surplus in buying land. Is it true that the Corporation has such powers; and if so to what extent are they put into force? The Author mentions that to raise certain funds to be expended in improvements the Corporation sold the reversionary interest in a considerable portion of their leasehold estates. Could Mr. Pickmere say what is the acreage of the property now held by the Corporation that is not used for Corporation purposes solely, but let or leased, and the present income to the Corporation from this source?

He mentions the tramways and electrical undertaking as being valuable assets; could he now say what has been the total cost—say to the end of the last financial year—the total income for last year on each undertaking, the annual expenses, the annual payment on account of interest and sinking fund, and the balances that accrue as profit?

It is interesting to know who was the first engineer of the "Old Dock" at Liverpool, and the question might be asked as to why Liverpool has not erected any statue or monument or memorial to Mr. Thomas Steers?

COMMUNICATED REPLY.

Mr. Pickmere: With regard to the first question I may say the Corporation has no special powers such as are described by Mr. Whyatt, and if they had they would be inoperative, as there has been for some years past a deficiency in the City Fund Account, which has to be met by a City rate.

The acreage of property now held by the Corporation of Liverpool, not used for Corporate purposes, but leased to others, represents about 671 acres, and the income therefrom is about 71,000*l.* per annum.

I append hereto a statement showing the financial position of the tramways and electrical undertakings of the Corporation.

The remarks of Mr. Whyatt regarding Mr. Steers, the designer of the first Liverpool dock (which was the first dock constructed for commercial purposes in England) are, I think, worthy of consideration, and I hope I may have an opportunity of obtaining, at some future date, due consideration of them.

UNDERTAKINGS FOR YEAR ENDED DECEMBER 31, 1906.

Undertaking.	Total cost.	Income.	Expenditure.	Interest and sinking fund.	Balance.	How allocated.
	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	
Tramways ...	1,901,997 3 10	571,216 7 1	385,405 4 1	*103,054 6 6	82,756 16 6	Reserve, Renewal and Depreciation Fund— £55,171 4s. 4d. In aid of general rate— £27,585 12s. 2d.
Electricity supply ...	1,901,246 1 7	258,769 1 11	101,709 9 5	*103,575 12 2	53,484 0 4	Reserve Fund— £18,771 19s. 2d. Renewal Fund— £13,884 16s. 6d. In aid of general rate— £20,827 4s. 8d.

* Tramways includes £5876 15s. 11d. for rent of leased lines, and both items have been reduced by interest upon investments.

THE DEFECTS, AND A SOLUTION, OF THE SOIL-PIPE, DRAIN, AND SEWER VENTILATION PROBLEMS OF THE NINETEENTH CENTURY.

By ISAAC SHONE.

Before proceeding to deal with the subjects of this paper, the Author begs to tender to the Council of the Incorporated Association of Municipal and County Engineers his warmest thanks for the honour they have done him in inviting him to prepare a paper upon a subject that relates to Drain and Sewer Ventilation—for presentation at this year's Annual Meeting of the Association.

He is aware that the members of this Association are eminently practical men, who attend their annual and other meetings, to encourage interchange of thoughts and experiences amongst each other, for the purpose of acquiring knowledge and instruction upon general as well as particular or sanitary engineering subjects—of which latter he ventures, in all sincerity to say there are none more in need of elucidation at the present time, and certainly none more important, in the whole and varied range of the professional municipal engineer's curriculum, than those which he has the honour in the pages of this short paper, to lay before and to discuss with them.

For the reason just stated, viz. that the members of this Association are practical men, having almost every moment of their time and attention continuously devoted to the daily increasing, not to say complex, duties which the Sanitary Authorities, in whose services they are, impose upon them, it would be out of place for the Author to preface the remarks he proposes to make in this paper, with anything approaching to an elaborate history of the evolution in this country, of the drain and sewer ventilation questions.

Suffice it to say that, according to a report addressed on March 18, 1858, to the London City Commissioners of Sewers and to the Metropolitan Board of Works, it would appear that, previous to 1830, "the sewers were ventilated by the gulleys, which were large open shafts, or shoots, connected with the sewers without traps of any description; they were connected with gratings of large size, the bars of which were farther apart than those at present in use; there were no ventilating shafts rising to the centre of carriageways, nor were there any side-entrances by which access to the sewers could be had. Whatever ventilation took place, therefore, was effected by the gulleys, and if a sewer required to be cleansed or examined, the mode adopted was to open holes in the centre of carriageways down to what are technically called manholes, or working-shafts, and perform these operations from these apertures, the shafts being left open a sufficient length of time to ensure ventilation before the men descended, and if there was fear of an accumulation of gas or mephitic vapour, which sometimes was the case near the heads of sewers, but at few other points in them."

Subsequently, "a gulley trap was devised and fixed in the Pavement, Finsbury, in 1834; and, in 1840, nine hundred of the gulleys had been trapped, with a view to remedy the evil, with the following results:—

"It became apparent, even before that number was fixed, that the sewers were becoming dangerous to workmen to enter, and the gases generated found vent by the house drains (then generally untrapped) into dwellings;" and with a view to try to ameliorate the insanitary conditions, brought about by the gulley trap invention, "ventilating shafts, connecting directly with small iron gratings in the centre of the carriageways, were formed: this mode of ventilating was also first adopted in the City, and the system of trapping (with numerous modifications in manner) and ventilating the sewers in the centre of the carriageways spread through the length of the metropolis."

But this arrangement again, in its turn, failed to suppress sewage gas generated in and issuing from the sewers. The gases then escaped into the atmosphere through the holes in the iron manhole covers fixed in the centre of the streets for the express purpose of ventilating the sewers. This simple

plan was then, as now, thought by many to be the proper and natural way of ventilating the sewers.

Later on, the General Board of Health was appointed by the Act for the Promotion of the Public Health passed in 1848. This Board was reconstructed in 1854, and afterwards, in 1858, it was incorporated into the Privy Council Establishment; the late Dr. Simon being retained as Medical Officer. Amongst other things, this Board prescribed rules and regulations for dealing with the management of sewers and drains. Here is a brief extract from the minutes of its transactions:—"Make proper provision for the ventilation of sewers and drains in such a manner that there may be a free current of air in them in the direction of the sewage flow:" it also recommended "that the stack pipes should be connected with the sewers without the intervention of traps, in order to assist the ventilation, and there should be no trap between the trap at the inlet and the sewer."

These proposals were adopted at Croydon—which was one of the first towns to carry out works of sewerage under the General Board of Health—with the result that some time after the works had been executed, and were in use, an outbreak of enteric fever took place in that town. The Local Government Board, which was formed by Act of Parliament in 1871, was in existence at this time, and accordingly that Board deputed one of its inspectors, the late Sir George Buchanan, to report upon the outbreak; and the statements made by Sir George on the subject will, the Author hopes, be borne in mind by the Members of the Association, because they are so transparently sound and correct, from his point of view, as showing the more or less grave dangers which must always attend the act of putting house soil-pipes, and drains, in direct communication with public sewers, for ventilation purposes. The following is a copy of the particular paragraph which the Author desires should receive special attention and be incorporated in his paper:—

"The air of the sewers is, as it were, 'laid on' to houses; it is arranged that every house drain and every house soil-pipe shall contain, up to the very wall of the house and up to the very trap of the water-closet, the common air of the Croydon sewers, not simply charged with impurities it may receive from the particular house, but charged also with any dangerous

quality that it may have brought from other houses; for hardly anywhere in Croydon can there be found an arrangement for severing the sewer air from the air of the house drain; so that wherever drain air has entered the house, no matter by how inconspicuous a defect, and no matter whether it has given rise to stink or not, it has been the air of the common sewer."

The plan of ventilating sewers through street surface ventilators, was also, as you are all aware, approved of and prescribed by the first Chief Engineer of the Local Government Board, the late Sir Robert Rawlinson, in his valuable "Suggestions," for the guidance of Municipal Surveyors and Engineers; but the other subsidiary plan, approved of by the General Board of Health, for ventilating public sewers by house drains and soil pipes—as well as by street surface-ventilators—the Local Government Board disapproved of, as is evidenced by section 63 of the latter Board's Model Bye-laws, which were based on the Public Health Act, 1875, and which were published in "annotated" form, in 1877, under the auspices of the Local Government Board, by Knight & Company, the Local Government Publishers. Section 63 of the Bye-laws reads as follows:—

"DRAINS TO BE TRAPPED FROM SEWER.

"Every person who shall erect a new building shall provide, within the curtilage thereof, in every main drain or other drain of such building which may directly communicate with any sewer or other means of drainage into which such drain may lawfully empty, a suitable trap at a point as distant as may be practicable from such building and as near as may be practicable to the point at which such drain may be connected with such sewer or other means of drainage."

The brief history, just given, brings us practically down to the present time; and now the Author would ask your indulgence whilst he ventures very respectfully to criticise in the most friendly spirit possible the drain interceptor trap invention, prescribed by the Local Government Board, as per sec. 63 of their Model Bye-laws.

To begin with, he entirely approves of the principle of the apparatus, as it will, when properly designed, answer the purpose for which it was intended. But unfortunately its practical action whilst performing its functions, as it is now

used, is to pollute the air of part of the private house drains and the whole of the air of the public sewers to an enormous extent.

To illustrate what he wishes to say about it, he has had prepared as an exhibit to accompany this paper, the drawing marked No. 1, which shows the manner in which, under the Local Government Board Model Bye-laws, house drains were and are to be connected up to the public sewers; and how the private house drains themselves were and are to be constructed, so as to prevent the foul air from the public sewers entering them. This drawing shows the arrangements prescribed for—

(1) Constructing a private air-tight house-drain inspection chamber;

(2) For fixing in it a hydraulic sewage-gas interceptor trap; and

(3) An arrangement for fixing in the inspection chamber a ventilating pipe, having at its upper end a mica flap valve to admit fresh air from the atmosphere to flow into it, for the purpose of ventilating the inspection chamber and the house-drain, soil, and other waste pipes connected therewith.

The mica flap valve on the air inlet when closed, although intended to prevent the foul air forced by water closet and other liquids discharged down soil and other waste pipes from escaping into the atmosphere of the house premises, does not always do so effectually, as most of you will be well aware.

The arrangement shown on the drawing has at least one serious sanitary defect: It makes no provision whatever for the ventilation of the house drain on the sewer side of the interceptor trap; and the consequence is that the air in that part of the drain is everlastingly imprisoned in it, and consequently that air must be everlastingly foul. To this obvious insanitary fact must be added another one, viz. the fact that the contents of the interceptor trap—owing to its being too large or capacious, and for that reason not self-cleansing—are too often quite as putrid as cesspool sewage. Thus in a vast number of cases these interceptor hydraulic traps on house drains, and especially house drains which are the recipients of small volumes of sewage, act the part of miniature cesspools, which give off sewage-gas on both the house and the sewer side of them. Not only is this the case, but when fresh sewage passes into them, on the house side of them,

that fresh sewage has the hydraulic effect of displacing its equivalent volume of cesspool-like sewage out of them, into the public sewer. Moreover, as every house drain thus connected with the public sewer, does likewise, and as the public sewer itself may be extremely badly ventilated, as it too often is, it is no wonder that the air emitted from such sewers whether through street surface gratings or high street vent shafts into our streets, or into our houses and other buildings, through defective drains, interceptors, and soil and other waste pipes, gives offence, and is rightly regarded as being one of, if not the most powerful agents for invisibly poisoning the air that is breathed, the water and milk that is drunk, and the fish, flesh, and fowl which are eaten by the inhabitants of badly sanitated houses, situated in cities and towns which have been drained on the English Water Carriage Plan of sewage removal.

He is well aware of the fact that numerous and various efforts have been made from time to time by members of this Association (the names of some of whom he would much like to mention, but it would be invidious to do so, in this paper, at least), to ventilate drains and sewers—if not exactly in the manner prescribed by the late Sir Robert Rawlinson, and the Local Government Board, and the General Board of Health, and the late Metropolitan Board of Works, yet in some such manner or on some such lines, so that the ventilation should be effective, and that sewage gas nuisances, which now too often invade our houses and streets, should be rendered as reasonably non-existent, and as harmless, in a sanitary sense, as possible. He is also well aware that there is, and very naturally so, a great diversity of opinion among the members of your Association, as to the relative merits and demerits of the several ventilating plans referred to, *e.g.* in Vol. XXIV., 1897–8, of your Association's records of its Transactions, there is a very instructive Report indeed of an important meeting of the Metropolitan surveyors, which took place at the Institution of Civil Engineers, on February 18, 1898, at which the subject of drain and sewer ventilation was very fully and ably discussed, but at which the members present failed to agree as to what particular part or parts of the existing orthodox plans of ventilation, or any modifications thereof, should or should not be recommended for adoption by the London County Council. Some of the members who took part in the discussions at that

meeting favoured the plan of adding to the existing number of street surface ventilators, so that they should be placed, say, at about 50 or 60 yards apart, and that each street surface ventilating opening in the manhole covers should be equal in area to at least 63 square inches, as recommended by the Metropolitan Board of Works in 1886. It would appear that in this same year (1886) the late Mr. Mansergh advised the adoption of that plan for the ventilation of the sewers of Hampstead. It was contended, and still is, the Author believes, by the advocates of the Metropolitan Board of Works' plan of ventilating sewers, that, if that plan had only been systematically adopted throughout the Metropolis, it would have given almost universal satisfaction, especially if it were supplemented, as its advocates proposed it should be, with an adequate number of high, street-ventilating shafts; air, it was claimed, would then descend into the sewers through openings in the street surface manhole covers, just as air descends into downcast shafts of mines, and afterwards it would ascend out of the sewers through the high, street-ventilating shafts, and back again into the atmosphere. This at least was and is the theory propounded by the advocates of this plan for ventilating sewers by natural means; and to get over the difficulty connected with the ventilation of that part of the house drain which lies on the sewer side of the interceptor trap, it was suggested at the same Metropolitan Surveyors' Meeting, that an entirely new or separate ventilating pipe should be laid right away from the drain on the sewer side of the interceptor, up to and above the roofs of the houses, as indicated by dotted lines on Drawing No. 1.

What the Author (and his partner, Mr. Ault) think of the proposals just enumerated, and what their views are with respect to the existing drain and sewer ventilation methods as a whole, and what it is suggested should be done to amend them in the future, the Author will presently endeavour to explain.

The long and varied practical experience acquired in metallic and coal mining and sanitary engineering generally has long since led the Author (as well as his partner) to the conclusion that drains and sewers can be better ventilated on the positive down-draft principle, brought about by mechanical means, than they can be by the up-draft principle, brought about by natural means, which is now almost universally relied upon for this

purpose; and, believing this, he has endeavoured to devise a simple, effective, and economical system for ventilating drains and sewers on the principle on which coal mines are ventilated, and he is sanguine that he has succeeded in his efforts in so doing; and in order to enable the Members of the Association to fully appreciate the difficulties that are inherent in the problem, which he now believes he has solved, he has thought it desirable to deal in detail with the adverse conditions which affect the ventilation of all main and tributary sewers, wherever existent, and to explain how, in his opinion, such conditions can be practically overcome.

The new system has been called the "hydro-mechanical" system because, as its name implies, mechanical power is employed to drive a fan for the purpose of creating vacuum or air-exhausting power, as is done in connection with the ventilation of mines; and the natural plenum power that is created by water-closet discharges falling down soil pipes is also to be utilised on the hydro-mechanical system, to augment, as much as possible, the volumes of air that will be drawn down the soil pipes into the drains, and through these into the sewers, by the exhaust action of the fan, wherever the ventilated interceptor traps, shown in Drawings Nos. 2 and 3, will be in use.

That the Members of the Association may thoroughly understand how the Author proposes to apply the principle upon which mines are ventilated to the ventilation of soil pipes, drains, and sewers, he has had the large sectional perspective Drawing No. 4 specially prepared, as an exhibit, for hanging on the walls of the room in which this paper will be read: the drawing, of course, is intended to be illustrative only, to demonstrate in fact, as he thinks it does at a glance, in what essential respects the proposed new methods for ventilating soil pipes, drains, flush tanks, interceptors, and sewers differ from those which are now in vogue in this country.

It will be seen from the Drawing No. 4 that the adoption of the Hydro-Mechanical system of ventilation will practically involve the reversal of the existing methods, but that, notwithstanding this radical change, it can be readily adapted, either to existing old, or to proposed new, drainage and sewerage works, whether such works are on the "dual" or "combined," or on the "separate" system.

The drawing exhibited, however, shows how private house drainage, and how public sewerage works, on the dual or combined system, can be ventilated on the Hydro-Mechanical system. All that is necessary to be done to set the new system of ventilation in operation is to provide and erect a fan and motor at some convenient place, where it can be built and fixed in a chamber above or below ground. The fan can be driven by steam, gas, oil, or electrical power. The Author, it will be seen, has elected to show on the Drawing No. 4, the necessary fan and motor chamber, as well as the air-purifying, or filtering chamber, under the street and alongside an egg-shaped public sewer; because, by so doing, all the ventilating machinery would then be "out of sight and out of mind;" and, moreover, such an arrangement would not involve the sanitary authority installing the system in the purchase of surface lands that would otherwise be required for the purpose. Besides providing the fan and motor, it would be necessary to provide and fix as many of the special interceptor traps—shown in Drawings Nos. 2 or 3—as there would be house drains to be ventilated by them; also one or more of the small special regulated air inlets, of the type marked on the Drawing No. 4 "R.A.I.," would be required in connection with the ventilation of house-drainage work. Again, in order to ventilate the pipe which carries the surface-waters from the street gulleys into the sewer, as indicated on the Drawing No. 4, as many special regulated air-inlets, having automatic aluminium reflux valves attached to each, should be provided and fixed as shown, or otherwise, as may be most convenient; the number of these latter to correspond to the number of gulley-drains to be ventilated. It is intended, as will be seen from Drawing No. 2, to fix the special ventilated interceptors in ordinary house-drain manhole chambers, having perforated entrance-covers, to permit of free ventilation in the chambers; and it will also be seen that the drains and the interceptor traps to be laid on the inverts of the ordinary manhole chambers in question ought to be wholly—as they are shown—covered, and, of course, all should be made air- and water-tight. That part of the drain-pipe which joins the interceptor on the house side of the latter should have a movable air-tight cover fixed over it for inspection purposes, as shown in Drawing No. 2.

The form of the improved interceptor trap itself resembles

somewhat the best types now in use; but the improved interceptor shown in Drawings Nos. 2 and 3 differs from all others, in that it not only permits of the sewage water-seals on both sides of it to be ventilated, but, what is extremely important in a sanitary sense, it also permits the air on the house side of it to pass over it into the drain on the sewer side of it to ventilate it.

In order to effect this innovation to ventilate the drain on both sides of the interceptor, it will be seen that the Author has inserted two small and short pipe openings in the body of the interceptor itself, well above the level of the trap waters on either side of it; these pipe openings have socket terminals in which are fixed air pipes of the shape and form shown in Drawing No. 2. One of these air pipes—the one which stands perpendicularly in its socket on the sewer side of the interceptor—has a special cap piece at its upper end, and to this is fitted a very sensitive and mechanically precise aluminium reflux valve, which opens freely when the current of air flowing from the house-drain is sufficiently strong to compel it to do so; but which, on the other hand, when plenum actions take place in the sewer, instantly closes again. By the aid of this simple sensitive reflux valve, the foul air of the sewer can be prevented from gaining access to the house drain on the house side of the interceptor, as effectually, sanitarily speaking, as it can be by the interposition of the water trap of an efficient interceptor.

The hinged valves used are made, as will be seen from Drawing No. 2, in the form of spherical segments, with their concave sides resting against the valve seating. The valves are carefully stamped out of thin sheet aluminium, and ground true to their seatings so as to be quite air-tight, and they are accurately suspended from pointed screws, and balanced so as to open and shut with the least movement of air; and as aluminium is very light and strong, and is not oxidised by air and not attacked by sulphuretted hydrogen, carbonic acid or hydrocarbon gas, its durability and uncorrodable character may be relied upon.

Drawing No. 3 is a facsimile of No. 2, so far as the shape and make of the house-drain manhole chamber is concerned; but in Drawing No. 3, the iron entrance cover is made air- and water-tight, and the drains within the manhole chamber which carry sewage from the house to the interceptor are open and

semi-circular in shape. The body of the interceptor, too, in this chamber, although hydraulically the same as the interceptor shown in Drawing No. 2, has only one air opening in it; and the hood-piece at the top of the perpendicular air pipe—which is in communication with the interceptor and in which the regulated air inlet piece and the aluminium reflux valve are fixed—is so designed that the air of the manhole chamber can readily enter it to ventilate the drain on the sewer side of it.

The Author designed the arrangement shown in Drawing No. 3 because he thought that possibly some engineers and others accustomed to seeing the inverts of the drains exposed in the existing open manhole chambers, might still like to continue to build them on the principle and after the pattern shown on Drawing No. 1, although, at the same time, probably many of them might be willing and even anxious to adopt the ventilated interceptor apparatus, with its accessories, which are shown in Drawing No. 2, if only they were quite sure that by the adoption of that arrangement they would be enabled to successfully ventilate the house-drain on the sewer side of the interceptor. The Author thinks it is a great mistake to put the air of the house drain in direct communication with the air of the manhole inspection chamber, because, by so doing, if the air of the drain is foul, the air of the manhole chamber, by the operations of the law of diffusion of gases, will be made foul also; in fact, the extent to which the atmosphere that is within and without dwellings is polluted, by our permitting the air of the drains, soil and other waste pipes, to be in direct communication with the air of the manholes with which they are connected, is appalling. Take, for example, the house-drain on the left of the interceptor, shown in Drawing No. 1, to be 4 inches only in diameter, and 66 feet long; and that the manhole at the interceptor is 6 feet deep, 2 feet wide, and 3 feet long; the cubical aërial contents of such a manhole would be about eight times greater than the cubical contents of the drain itself. In other words, by substituting the manhole ventilated from the open air, and the covered drain and ventilated interceptor, shown in drawing No. 2, for the arrangement which now prevails, and which is shown on drawing No. 1 the volume of drain air in the immediate vicinity of dwellings would then only be the one-eighth of what it would be otherwise. The same remarks apply more or less to the polluted air

of manholes, which is in direct communication with the air of ill-ventilated public sewers, and which is so foul at times that many of the workmen who are obliged to pass up and down them are rendered unconscious by partial asphyxiation, and not a few of them are too often killed outright by it. To prevent these deplorable preventable accidents, all the street manholes (which are built over or on the side of main sewers) that are, or may be, used by the workmen whose business it is to see that the sewers are kept in a proper state of repair, should always be adequately ventilated, somewhat on the lines, or in the manner shown in Drawing No. 5.

It is obvious that so long as the present unscientific and unphilosophical state of things is allowed to continue, the public must continue to put up with the insanitary consequences, while it is equally obvious to the Author that if the Members of this Association recommended their employers to dispense altogether with non-ventilated interceptors of the type shown on Drawing No. 1, *i.e.* in connection with all new house and town drainage works, and substituted for it one of the ventilated types shown in Drawings Nos. 2 and 3—preferably the one shown on Drawing No. 2—a most important and far-reaching sanitary improvement, upon existing methods, would immediately result therefrom; because the soil and other waste pipes connected with the interceptors and drains, and with the sewers as well, would then be ventilated, partly by the air which would be forced by w.c. and bath discharges down the soil and other waste pipes into the drains and sewers, and partly by the air that would flow by gravitation down the soil and other pipes into the sewer, whenever the air in the latter was of a lighter specific gravity than that of the outside atmosphere surrounding the roofs and the tops of the soil and other pipes. These latter would then act the part of downcast shafts, and the sewers themselves would become the equivalents of upcast shafts, on the principle upon which furnace ventilation is brought about in mines: *e.g.* if the temperature of the air of the sewer became, at it would do at times, 10° Fahr., more or less, higher than the air of the drain on the house side of the interceptor, then undoubtedly a current of air would be induced to flow from the drains on the house side to the drain on the sewer side of the interceptor. If this latter be 30 feet long to the sewer, and we treat it as a chimney or upcast shaft of that

length terminating in the atmosphere outside and not in the atmosphere inside of a sewer, then the velocity at which the air would flow to the sewer through the regulated air inlet opening of the interceptor would be, allowing 33 per cent, for friction, about 4 feet per second. If the regulated inlet be circular in shape, and 1 inch in diameter, the volume of the ventilating current would be equal to 1·32 cubic feet, or 8¼ gallons per minute. But of course the drain and sewer air conditions here stated are purely hypothetical, and are not on all fours with the conditions that obtain when heated air escapes from steam boiler furnaces into and up chimneys, or when heated air escapes from the like furnaces, placed at the bottom of the upcast shafts of coal mines, into and up such shafts into the atmosphere for mining ventilation purposes. The similarity between the conditions cited, however, is sufficiently approximate to induce the Author to draw your attention to them, and particularly to the fact that, under the variable high temperature conditions which are continually occurring in sewers, sensible currents of air could not fail on such occasions to flow into, and help to ventilate house-drains, interceptors, and sewers alike; and that such naturally induced currents, supplemented by others, resulting from the falling of w.c. and other waters, down soil, etc., pipes would, if conducted into sewers through drains possessing the apparatus shown in drawings Nos. 2 and 3, even without mechanical aid, effect improvements upon existing methods, which would, as already stated, be of incalculable sanitary value.

But self-cleansing drains and sewers ventilated throughout on the Hydro-Mechanical system—allied to the natural ventilation conditions just explained—could not fail to render our so-called English Water Carriage System of sewage removal as "reasonably perfect," as the late Professor Huxley, and a host of other eminent sanitarians of the last century, desired it should be, and, as the Author is confident it can and will be made to be, sooner or later, and the sooner the better he says, and so, he feels sure, the Members of this Association and their employers will say too.

The Author will now state something about the work of circulating air in drains and sewers.

The frictional resistances of air in sewers may be found from formulæ similar to those used by hydraulic engineers for

water; but, as water is 800 times heavier than air, the frictional resistances for air will only be about the $\frac{1}{800}$ part of what they will be with sewage or water. The frictional conditions applicable to the act of transporting air through pipes, however, only become quite analogous to those which apply to water, when the drains or sewers are free of liquids and are charged full bore with air, the reason being that what we call the "pneumatic" mean radius of a drain or a sewer only corresponds to the hydraulic mean radius of a water-pipe when the latter is flowing full bore with water. When it is partially filled with water and partially filled with air, the pneumatic mean radius is found by adding the transverse length of the water surface in the drain or sewer to the length of the unwetted arc-perimeter of the drain or sewer, and by dividing the sectional area of the sewer (in square feet) by the sum of these two lengths in feet.

The ordinary formula for finding the frictional resistance to the flow of air in channels, as given in most text-books on the subject, is

$$h = \frac{l \times v^2}{52{,}750 \times d \times r_p} \quad . \quad . \quad . \quad . \quad . \quad (1)$$

where h = the frictional resistance in inches of water,
l = the length of the sewer in feet,
v = the velocity of the air-current in feet per second,
d = the diameter of the sewer in inches,
r_p = the pneumatic mean depth which for circular pipes flowing full bore = 0·25000

If the pipe is $\frac{1}{4}$ full of sewage r_p = 0·21343
" " $\frac{1}{2}$ " " = 0·15275
" " $\frac{3}{4}$ " " = 0·08044

As, however, the air from the house connections or other inlets enters at a number of points, and the volume of air, and consequently also the velocity of the air current, is a gradually increasing one, then the above formula must be modified to these conditions; and the Author has therefore adopted the following formula, which is a simplified form of the formula given in Mr. Edwin Ault's paper on "The Ventilation of Drains and Sewers," which was read before the Civil and Mechanical Engineers' Society in 1902, and which is based on the fact that the frictional resistance is very nearly equal to the square of the average velocity. The formula is as follows:—

$$h = \frac{l\left(\frac{v_1^2}{6} + \frac{v_1 v_2}{2} + \frac{v_2^2}{3}\right)}{52{,}750 \times d \times r_p} \quad . \quad . \quad . \quad . \quad . \quad (2)$$

where v_1 = the initial and v_2 = the final velocities in feet per second.

When the difference between v_1 and v_2 is small, as is often the case, and where the frictional resistance in a number of consecutive lengths of sewers of various diameters are to be calculated, a still simpler formula may be used, viz.:

$$h = \frac{l \times v_1 \times v_2}{50{,}000 \times d \times r_p} \quad . \quad . \quad . \quad . \quad . \quad (3)$$

Sudden variations in the velocity of the air currents, as, for instance, that caused by passing air through a pipe of a smaller diameter into one of a larger diameter without admitting a larger volume of air, lower the efficiency of the fan, and should therefore be avoided.

The same may be said about sharp bends and all openings having sharp edges, as, for instance, when the air-current passes through an ordinary manhole with open invert into the sewer beyond.

The power required to move the air by means of a fan can be found approximately, when the size of the delivery pipe is known, from the following formula, which is for fans of good design:

$$\text{B.H.P.} = \frac{u^3 \times a \sqrt{1 + h}}{250{,}000}$$

where u = velocity of air through delivery pipe of fan in feet per second.

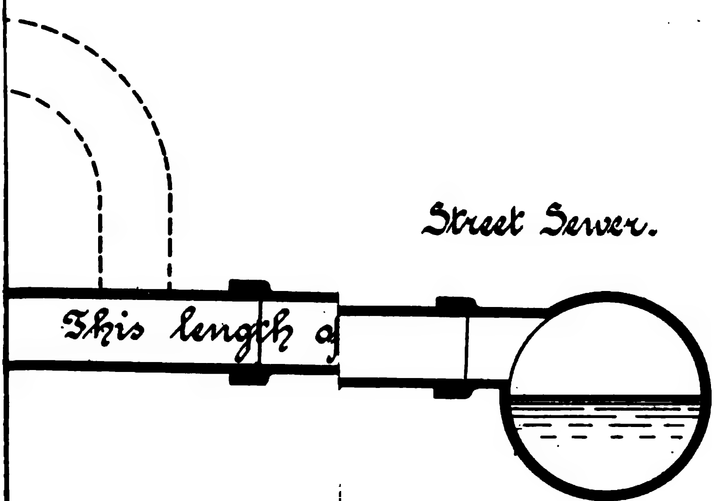
a = area of delivery pipe in square feet.

h = total pressure against the fan (suction and delivery) in inches of water.

In towns with electric supply where current for motors is sold at low prices, the electric motor forms a source of motive power which is admirably suited for driving fans for ventilating drains and sewers. It is cheap, compact, and reliable, and can be made to run the fan at any required speed. By its aid, therefore, it becomes an easy matter to divide a town up into any convenient number of ventilating districts, and to provide

PLATE No. 1.

in vogue ouse Drains.

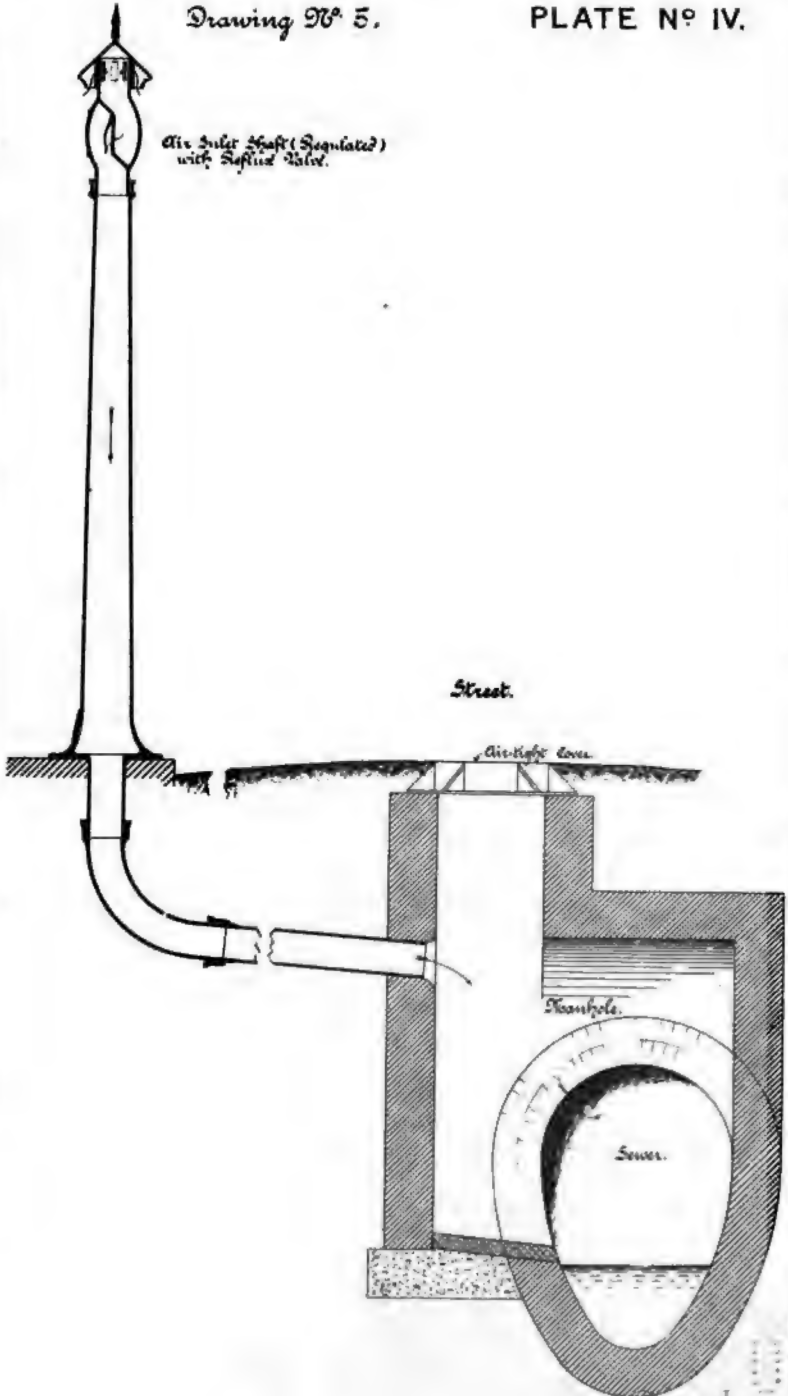


To face p. 368.

RETT & SONS, 19, BARTLETTS' BUILDINGS, HOLBORN CIRCUS, E.C.

Drawing No. 5.

PLATE No. IV.



To face p. 368.

"PHOTO-LITHO." R.J. EVERETT & SONS, 19, BARTLETTS' BUILDINGS, HOLBORN CIRCUS, E.C.

each district with a fan and motor erected in a small chamber under the street surface, and to deliver the air into a ventilating shaft or elsewhere.

The objections made, so far as the Author is aware, against the Hydro-Mechanical System of Ventilation, are more or less typical of the kind of objections which new things for ages past have encountered, in the first instance, whatever the character or intrinsic merits of the new things may have been. For any one, however, in these pronounced municipal economy days, and especially the inventor of new sanitary things, to undertake to talk of Municipal and Sanitary Engineering Reforms, of all subjects, and in the presence, too, of the engineering advisers of the sanitary authorities of this country, is, to say the least, a formidable task; but, nevertheless, the Author has not flinched from undertaking it, knowing full well as he does how earnestly desirous the Members of the Incorporated Association of Municipal and County Engineers are to acquire the most reliable and best possible information concerning the all-important subjects of drain and sewer ventilation problems. In fact, he is unfeignedly thankful for the privilege which this paper affords him of laying before the Association his own and his partner's views as to the ways in which the problems in question can be scientifically and practically solved for all time.

DISCUSSION.

Mr. P. Dodd: It seems to me that Mr. Shone's method is an ideal way of dealing with this complicated question. It appears to be based on scientific principles, and the only possible objection that can be brought against it is on the score of expense; but when we consider the number of deaths that occur as the result of badly ventilated sewers and drains, the sooner the question of cost is dealt with by those in authority the better it will be for the health and welfare of the community at large. Years ago I had some experience in colliery ventilation, and had also some experience in drain and sewer ventilation, and the more I study this Hydro-Mechanical system, the more I am convinced that Mr. Shone has placed before us a practical scheme for solving this difficult problem.

Our present method of ventilating drains and sewers by natural means must of necessity be spasmodic, for it depends more or less on the state of the atmosphere, the direction of the wind, and other circumstances, whereas, in Mr. Shone's scheme, there is a regular current of air created irrespective of the conditions of the atmosphere. Moreover, instead of bringing the foul air to the vicinity of the houses, as is done at present, it is taken to a point some distance away, to the fan where it is filtered and rendered perfectly innocuous before it is allowed to escape to the external air. As we all know, there are miles of drains in most of our towns, between the intercepting trap and the sewers, which are not ventilated, and for that, among other reasons, I am one of those who believe in the abolition of the intercepting trap on the house drain; but in the system before us we are provided with an ingenious arrangement, shown on Drawing No. 2, for ventilating, not only the drain on the house side, but the drain on the sewer side, of the trap, and therefore one of the chief objections to the interceptor is got rid of. Then, again, by sealing the drain at the bottom of the intercepting chamber, as shown on Drawing No. 2, the usual air inlet is dispensed with, and the chamber is not liable to be filled with sewage, as is the case when the trap happens to be blocked. Another great advantage in the scheme is that it can be adapted to existing sewers and drains without much difficulty, and apparently, so far as owners of property are concerned, without much cost. If authorities like the London County Council, who have control of the large main sewers, can adopt a scheme of this sort and get rid of the volumes of foul air which are bound to accumulate during the dry-weather flow of the sewage, and which, during certain states of the atmosphere are practically stagnant, it would be a very good step in the right direction. In conclusion, I wish to propose a vote of thanks to Mr. Shone for his valuable and interesting paper, and for the elaborate drawings which he has prepared to illustrate his scheme.

Mr. W. Weaver: I have very much pleasure in seconding the proposition. I have had the pleasure of perusing the paper Mr. Shone has written on this interesting subject, which has occupied in past years a good deal of my attention, and I have also seen an installation of Mr. Shone's system. I am of opinion he has cleverly and scientifically solved the problem of

properly ventilating sewers, provided they are made air-tight. So far as London experience is concerned, the root of evil smells is the main sewers, and the method of remedying the simple one of closing up the vent, and thereby increasing the volume of smell thrown into the subsidiary sewers, leaving the local authorities the task of dealing with the infuriated ratepayers, who naturally object to sewers discharging their gases under their windows. If the London County Council could be induced to make experiments upon one of their main line sewers and thoroughly test it, and, if successful, extend the system to other main sewers in the Metropolis, I do not think there would be much left for the local authorities to remedy.

MR. A. E. COLLINS: I should like to support the motion of Mr. Dodd. I look upon Mr. Shone as the man who, with his ejector, has made the only fundamental improvement in sewerage since the time of the Romans. Mr. Shone has the advantage over most other people of having lived to see the fruition of his invention, and I hope such may also be the case regarding Mr. Shone's system of ventilation. It would be valuable if the London County Council would try the experiment suggested by Mr. Weaver, and see if we can get the air purer in our long lengths of sewers.

MR. MAWBEY: I read a paper at Shrewsbury on this subject, and I explained that we had put down an installation at Leicester a little over four years ago to 80 houses, with a population of 356. Although I was dead against Mr. Shone on this question to begin with, after a lot of consultation with Mr. Shone I saw something in it. We applied it at Leicester, and what I want to tell you is this—it absolutely swept away all ideas of traps being unsealed by his system of mechanical ventilation. We had made many experiments, and we never could get a vacuum, but in this system we found it was quite practicable to ventilate drains and sewers. Another thing we found—we had had a great many analyses taken from the new and old sewers at Leicester, which were ventilated by pipe-shafts, and I can tell you that carbonic anhydride was very substantially reduced by this system.

MR. A. M. FOWLER: When at Leeds, I made many connections with mill chimneys there. There is great heat in mill chimneys, and very great height, and the draught of the furnaces was very great. Despite this, you could not

get a current of air down the sewers for more than 200 or 300 yards—150 yards—from the gulley holes and other openings, and places which, in a system of sewers, you cannot always secure as being hermetically sealed. I think the highest credit is due to Mr. Shone for the manner in which he has thought this scheme out. It is a very great advance; it is very ingenious and very scientific.

Mr. T. R. Smith: In the matter of ventilation, there are many points of difference between the ventilation of sewers and of collieries. In a mine there will usually be two openings only, an upcast shaft and a downcast, and there is no difficulty about the ventilation until you get to the working faces, where it is largely dependent on sheeting, which allows heavy leakage. This would seem to me to suggest that while it may be quite practicable to ventilate main lines of sewers in the way proposed, it may not prove quite so practicable when dealing with the ordinary sewers of the streets. There we have many openings, through which air would be continually entering, and while some of these openings, as Mr. Shone has suggested, could be regulated, there would be many others which could not be so regulated. For instance, traps usually only have about a 2-inch seal, and though we have been told in a certain instance they were not drawn by the suction of the fan, yet it would seem that they frequently might be, or the water-gauge at the fan would be very low, and not likely to promote ventilation for any great distance. The matter seems to me to resolve itself into some practical considerations rather than into calculations, which would be easy, of how much air you can get along a sewer of a certain size. Take, for example, a town of any size you like, how far along its ordinary street sewers will the influence of a fan be felt, with the many openings through which air will be entering. If some information could be given as to how far a reasonably sized fan, at a comparatively small cost, could promote ventilation, under practical conditions, and the cost of running, it would give some idea as to how many such centres of ventilation would have to be established in such a town, and some idea of the cost of such an installation.

Mr. W. J. Steele: I am of opinion that sewers were intended for the conveyance of the refuse of a community, and I contend that the necessity for adopting any special means to pass atmospheric air through a properly designed sewerage

system, has never been proved. The trend of the discussion, like so many others on the same subject, seems to imply that the adoption of some special means is an axiom, but I venture to suggest that it is only an assumption based upon conclusions arrived at too hastily. It has been thought that if no means were undertaken, the water seal in the numerous traps would be forced. Has it ever been proved that any large sewerage system was so perfectly airtight throughout that the air pressure created during a heavy rainfall, or by the rise of the tide at sea outfalls, was so great as to cause the water seal in a considerable proportion of the traps to be broken? If this condition does occur, then most undoubtedly special means should be adopted in Bristol, where a large area of the sewerage system is tide locked twice a day. No special means are adopted in Bristol, and the manhole covers are closed, yet the general and zymotic death rates will compare most favourably with any town of similar size in the country. What should we gain by adopting any system of ventilating our sewers in Bristol? It would be a doubtful experiment, and if we spent the necessarily large sum required, it is a question whether it would do any good, but probably would give ground for very serious complaint, which does not occur under present conditions.

Mr. T. Caink: The whole basis of Mr. Shone's system of sewer ventilation is the assumption that it is necessary to have pure air in the sewers. That assumption, if true, would make the cost of purifying the air a secondary consideration. I agree with the last speaker that that assumption is entirely fallacious, and that therefore the whole system which is based upon it is fallacious also. The object of sewers is to convey foul matter. In comparing sewers with mines Mr. Shone has overlooked the fact that mines are occupied by persons who have to work in them, and sewers are occupied at the most by rats and foul matter. The case of Bristol proves that it is not necessary, since the health of Bristol compares favourably with towns which ventilate their sewers. The subject of sewer ventilation occupied my mind some quarter of a century ago; and it was experiments which I conducted at that time that convinced me that it was needless to endeavour to obtain circulation of air within the sewers. The effect of such circulation was to bring from the sewers an increased quantity of foul air, and that led

me to consider not how best to increase the circulation of air in the sewers, but how best to check it. Finally I arrived at the conclusion that all that was desirable to be done in regard to air in the sewers was to give the sewers such relief as to prevent the forcing of air through the traps into private drains. In doing that I provided for an arrangement which, while it prevented pressure upon the traps of the private drains, would allow sufficient air to escape from the sewer, but so slowly as not to be perceptible in any objectionable way. It is obvious that air must escape from the sewers at every increase of the level of the water therein. If a storm comes, and the sewers become charged with liquid, the air which previously occupied the space must escape somewhere, and I think it is desirable to provide some known means of escape, rather than allowing the air to escape in a haphazard way, nobody knows where, such as takes place at Bristol. Clearly that is the rational thing to do.

MR. J. PRICE EVANS: Taking Mr. Shone's system he converts soil pipes into downcast shafts taking fresh air into the sewers. I cannot agree with our friend from Bristol in that he has not got his sewers ventilated, because wherever there is a flow of sewage there is bound to be a certain amount of air going down. I hope we shall take this system into serious consideration, because the more fresh air we get into our sewers the better it will be for all.

COMMUNICATED DISCUSSION.

MR. T. W. A. HAYWARD: The paper submitted by Mr. Shone is most interesting and instructive. That something ought to be done in regard to more efficient ventilation no one will dispute. The sewers in our large towns are in many cases nothing more or less than death traps to the men that have to enter them, and any scheme that will remove the dangerous condition of our sewers should be welcomed by municipal engineers. During the summer months of every year, borough engineers in London are inundated with complaints as to smells from sewers, and I quite agree with the Author of the paper that this nuisance should demand greater attention from local authorities than it has hitherto done.

Mr. Shone's suggestions are original, and I should very

much like to see an experiment tried, on the lines laid down by him, in some of the sewers of the Metropolis.

The scheme appears to me to be very carefully thought out. It is simple in construction, and there are very few parts that are likely to get out of order. I should like the scheme better if the reflux valve on the interceptor trap could be modified in some way, as backpounding is not unknown, and I am afraid the valve might not always act in the way one would desire.

The idea of adopting means to draw air into the sewers from the pipes round buildings, and discharging it at a distance from buildings, is very much better to my mind than allowing air to enter into, or escape from, sewers as in the present haphazard manner.

MR. H. GILBERT WHYATT: While congratulating Mr. Shone on the ingenuity of his scheme for dealing with sewer air, I venture at the same time to disagree entirely with the argument that such a scheme for the ventilation of drains and sewers of small diameter is either necessary or desirable, however necessary it may be in the case of those large sewers into which workmen have to enter daily or periodically. In the extempore remarks made by Mr. Shone when introducing his paper, he quoted several instances of men being overcome by the foul gases, and stated that he had records of a very large number of such unfortunate incidents; but, with regard to the drains and sewers of small diameter into which it is impossible for men to enter, it is absolutely unnecessary, in my opinion, that they should be ventilated like mines, workshops, or nurseries. It is certain that the extensive use of the intercepting trap has considerably increased the foulness of the sewers, partly by retaining quantities of sewage until putrefaction commences, and partly by the interference with the ventilation of the sewers through the drains and vent shafts on private properties. The number of intercepting traps should be reduced to a minimum, one trap to a block of property being all that is necessary; and, in this case, the amount of sewage flows so continuously that no portion remains in the trap sufficiently long for putrefaction to commence. I cannot think that in the interests of pure air in sewers of small diameter, the air of the towns should be polluted by continuous streams of sewer air extracted by means of a number of fans; and all that is necessary is a sufficient number of vent shafts, acting simply

as relief openings in the case of a plenum pressure in the sewer and discharging the minimum quantity of air that may be necessary to relieve the pressure at a level a few feet higher than house roofs, and, when there is a slight vacuum in the sewer, acting as inlets. One defect in Mr. Shone's scheme appears to be the "very sensitive and mechanically precise aluminium valves" which are fixed in the intercepting chambers. There are very few towns where the sewers are not overcharged two or three or more times each year by a sudden afflux of stormwater lasting from a minute or two to a considerable portion of an hour, and after each such rainstorm, the whole of these underground valves would have to be taken out and cleaned; for the same reason it would be very inadvisable to put the fan-chambers and fans underground. Another objection seems to be the condensation of moisture. There are not many occasions when a manhole, however well ventilated, is opened up but the ironwork and brick walls are not found to be dripping with condensed moisture, and, although aluminium is both durable and incorrodible, yet this condensed moisture will affect the careful balance referred to. A further objection is the initial cost of the installation and the annual charge for electricity, inspection and maintenance, to which Mr. Shone, perhaps discreetly, makes no reference. The only guide to this, which I have been able to find, is in a paper by Mr. A. M. Fowler, M.Inst.C.E., Past President of this Association, which he read at the Annual Congress of the Royal Sanitary Institute in Manchester on September 10, 1902. In this he gave the cost of electricity only as 440*l.* per annum for a population of seventy-five thousand (5*l.* 17*s.* 10*d.* per thousand). He mentioned nothing with reference to interest and repayment on the capital expenditure, maintenance, or attendance. In these days of "pronounced municipal economy" very few municipal engineers would be able to induce their Local Authorities to embark upon such an expenditure, or, if successful, the Local Authority would not be likely, after the first two or three years, to continue such an expenditure as the above figures indicate. Mr. Shone strongly recommends that the length of drain between the intercepting trap and the main sewer should be ventilated, and this is being extensively done in many towns. In Torquay there are over two thousand shafts carried up from the sewer side of the intercepting trap;

and I am in Grimsby able to secure this in nearly every instance where a block of houses is erected.

In the paper on the subject of sewer ventilation which I presented to the District Meeting of the Association, when they did me the honour to visit Grimsby on April 23, 1904, among the conclusions which I arrived at, I stated that, in my opinion: "(4) The mechanical removal of sewer air by fans is too expensive for ordinary use in towns. (6) That the solution of the problem appears to be the adoption of a large number of reasonably sized ventshafts at frequent intervals (this being practically the adoption of surface ventilation at the level of a horizontal plane a few feet higher than house roofs); the vent shafts to be provided in all cases with rust pockets. (7) That sewers must be regularly and frequently flushed so that putrefactive matters may be removed before the production of foul gases commences. (8) That the ventilation of the length of drain between the sewer and the intercepting trap should be arranged for and carried out by the person building at the time of the erection of the property."

Mr. SHONE, in reply: I have often heard that the Bristol sewers are not ventilated, but I always think that they must be ventilated in some way or other, which only systematic investigators of them can discover and elucidate. Non-ventilated sewers, wherever existent, cannot fail to be a source of danger to the people in whose towns they are to be found. The undulating character or configuration of Bristol doubtless favours an amount of natural ventilation which has hitherto been unobserved. To cite the Bristol sewers as being worthy to be imitated elsewhere, seems to me, from a sanitary point of view, to be most impolitic, not to say a dangerous thing to do, because it is obvious to me, as it will be to others, that if it is wrong (which, of course, it is not) to ventilate the sewers of the twentieth century, then the premier sanitary axioms of the premier sanitarians of the nineteenth century are not only set at nought but rendered absolutely ridiculous. I believe, however, that the nineteenth century methods of dealing with the air of such soil pipes, drains, and sewers as are described in my paper, are doomed to come to a speedy end in the twentieth century, and those methods I confidently predict will be superseded by scientific methods devised on the lines indicated in my paper. But most certainly they will not be superseded

by the methods which are in vogue in Bristol, where it is alleged the drains and ordinary sewers, as well as the main tide-locked outfall sewers, are left to ventilate themselves! Mr. Caink's statement that it is unnecessary to ventilate sewers, because the only living things in them are rats, is not in accordance with everyday practical facts bearing upon the problem. In the sewers of London, for example, there are at times armies of men employed to maintain them in working order; and I know, as a matter of fact, that the present chief engineer, acting for the London County Council, has expressed himself, publicly, as being anxious that some efficient system for ventilating the London sewers—if only for safeguarding the lives of the men who work in them—will soon be inaugurated. To my certain knowledge many lives have from time to time been lost in ill-ventilated sewers in this country, and only the other day a cheque for 10*l.* was presented at Bow Street by Sir A. de Rutzen to Police-constable William Gough as a reward for his prompt and intelligent action in saving two men from asphyxiation by sewer-gas, emitted from a sewer into a manhole situate in Bethune Road, Stoke Newington. If these two men had died, of course a Coroner's Inquest would have been held, and doubtless the statements alone of eye witnesses to the jurors as to what had happened, in the absence of the evidence of an expert on scientific sewer ventilation, might, and probably would, have induced them to return a "verdict of accidental death," although possibly, in these days, the powers of the Act of Parliament which was passed last year, and which came into force this year, entitled "The Employers' Liability Act," would have been invoked, to compel those in whose service the unfortunate men lost their lives, to compensate and make pecuniary provision for the maintenance of their wives and families. I would also respectfully remind Mr. Caink that sewers that are chock full of sewage-gas feed, not only the street manholes connected with them, but every house drain connected with them with sewage-gas also, as explained in detail in the paper; and the moment such sewers are surcharged with sewage and rainfall waters above the crown of the drain at the point where it joins the sewer, that moment the interceptor trap on the drain will be unsealed, with the result that the foul sewage-gassed air contained in the house drain will be forced into the inspection chamber and drains on

the house side of the interceptor. I myself have seen the eye-piece of an interceptor forced out of its socket in this way. But as you will gather from the official reports and statistics of the medical officers of health of this country from time to time, the number of men who work in public sewers, and who sometimes lose their lives in them, is, after all, insignificant in the extreme, in comparison with the number of people, young and old, who directly and indirectly lose their lives by breathing impure air—rendered so by the mephitic vapours generated in and given off by the ill-ventilated drains and sewers of the present day. But by the adoption of the Hydro-Mechanical system, street surface ventilators could be abolished altogether, so also could the iron street-lamp-like ventilating shaft or column, shown on Drawing No. 5, be dispensed with, and the equivalent arrangement shown in Drawing No. 4, and marked "R.A.I.," could be substituted for it. That is to say, instead of erecting more or less costly iron ventilating shafts in the streets, which many people regard as unsightly and insanitary nuisances, an equivalent air-inlet and reflux-valve ventilating apparatus could be fixed in the street boundary wall, or in the kerb of the street parapet or footpath, for ventilating the street gully drains and the sewers at the same time, and at one-tenth of the capital cost of the iron columns. Each gully drain thus invisibly ventilated would always be productive of positive fresh air ventilating currents into the sewers. To say, as has been said by Mr. Caink and others, that the larger the volume of fresh air that was circulated in sewers the larger would be the volume of foul air that would get out of them into the atmosphere of our house premises and streets is absurd—*e.g.* if one poured into a vessel containing 1 oz. of pure whisky 3000 ozs. of pure water, the 3001 ozs. of liquid which the vessel would then hold would not be pure whisky, but pure whisky diluted with 3000 ozs. of pure water. In the same way if one diluted one volume of sewage-gassed air, which would asphyxiate men working in sewers, with 3000 volumes more or less of normal pure air, the resultant volume could be breathed, as the air of a well-ventilated room is breathed, with impunity. With regard to the very practical question put by Mr. T Reader Smith (Kettering), I hope presently to supply the necessary replies in book form. In the mean time I may state that two separate egg-shaped sewers, 3 feet by 2 feet, each to be 2 miles

long, or 4 miles altogether, flowing two-thirds full of sewage, and having 1408 house drains, and 282 street gully drains connected to them, and for each connection to contribute ½ cubic foot of fresh air into them, plus 50 per cent. as an allowance for leakages, could be efficiently ventilated by a fan requiring the one-fifth of a horse-power to drive it and for the motor to use about 8 British thermal units of electrical energy, costing, say, 1*d.* per British thermal unit, would amount to 8*d.* per day only, or at the rate of about 1*d.* per day per 1000 of the population. The water-gauge vacuum necessary to create, to effect, the ventilation would be under 1 inch at its maximum—*i.e.* at the fan—and the plenum necessary to force the air through the filter and up the outlet shaft into the atmosphere would be equal to about ½ inch or 1½ inch of water altogether. But at no house-drain interceptor, or street-gully trap, would the vacuum caused by the working of the fan required to ventilate the two separate hypothetical egg-shaped sewers, each to be 2 miles in length and both to converge at or near to the fan chamber, exceed ½ inch of water, and consequently there need be no fear whatever that any of the traps named will be unsyphoned, as Mr. Mawbey's practical experience of the system at Leicester—I am glad to find—has enabled him to testify to this meeting to-day. The cost of working the Hydro-Mechanical ventilation system will of course, vary according to the nature and quality of the apparatus to be supplied, the volume and character of the structural work to be executed, and the diameters and lengths of the drains and sewers to be ventilated by it, as already explained.

Again, as to what the cost would be of installing the improved and ventilated interceptor trap arrangement in lieu of the existing unventilated trap arrangement, I venture to say that the cost of the type of house-drain inspection chamber with its interceptor trap and its other accessories, shown on Drawing No. 1, plus the cost of the additional ventilating shaft which is carried up from the sewer side of the interceptor to the roofs of the houses, or elsewhere, as Mr. Whyatt says is done at Torquay and by him at Grimsby, would amount to more money than would be required to construct the same size and class of inspection chamber fitted complete with an improved interceptor, that will ventilate itself, and the drains connected to it, on the sewer- as well as on the house-side of it, practically

perfectly, as stated in my paper when describing more particularly the Drawing No. 2 that accompanied it.

One thing is certain, and that is that Shone and Ault cannot, nor can anybody else, in fact, compare, fairly at least, the costs of two ventilating systems—the one with the other—unless the diameters and lengths of the soil pipes, drains, and sewers to be ventilated, are the same in each, and the ventilation efficiency of each is taken into account. If the positive Hydro-Mechanical system does that which its advocates assert it will do, and the natural ventilation system, so-called, does not, and never can do, then a comparison of costs between two such systems would be misleading and worse than useless.

The present fashionable plan of multiplying tall vent shafts for the purpose of ventilating sewers, is a poor, unscientific makeshift, to say the least, because, surely, the more vent shafts there are, and the larger they are in diameter, the greater the volume of foul air they will hold. The multiplication of vent shafts, whether their tops are on one level plane or otherwise, cannot, when the air within and without them is still, have the effect attributed to them by Mr. Whyatt. As well expect such shafts, if filled with water to one level plane, will cause the water to circulate within them, as expect them to cause the air within them to circulate when that air and the atmospheric air without them is in a state of quiescence.

Additions to, or abstractions from, the volume of water in a water main supplying shafts like the vent shafts used by Mr. Whyatt, would have the effect merely of elevating or depressing the surface level of the columns of water within them to a very limited extent, and the like effects would result in the vent air-shafts by additions to or abstractions from the sewage contents of the sewer. A thousand colliery shafts, if used as vent shafts in the same way that Mr. Whyatt (and others) uses his shafts for ventilating the Grimsby sewers, would not ventilate the colliery and render it free from gas and fit for men to work in. Ventilation means, the circulation, not the stagnation, of air; and hence it is that by the aid of one or two down-cast shafts and one up-cast shaft on a very large colliery, which is mechanically ventilated, will suffice to clear away the gases evolved from the coal, and render the air of the colliery workings inexplosive, and fit in every way for the collier to breathe healthfully.

I confess that I am surprised at what Mr. Whyatt states with regard to the advisability or the necessity there is for ventilating big main sewers into which men are obliged to enter and work, and the inadvisability or non-necessity there is, from his point of view, of ventilating small drains and sewers which are too small for men to work in; because of the two types of sewage-carrying conduits the smaller is the one which, for the reasons given in the report of the late Sir Geo. Buchanan, on the outbreak of enteric fever which occurred in Croydon some years ago—and a quotation from which is given in my paper—is the more dangerous of the two.

I would here respectfully call Mr. Whyatt's attention to the recent discovery made by Major W. H. Horrocks, F.R.S., R.A.M.C., whilst investigating drain and sewer air with a view to find out, amongst other things, whether or not the interceptor trap was any good as a barrier to prevent the pathogenic germ-laden air of sewers gaining access to the private house drains; which discovery he communicated to the Royal Society in a paper which he read before that Society on February 7 last, and in which he demonstrated conclusively the fact that the water-seals of interceptor traps are effectual for the purpose; as the accidental breakage or removal of the inspection-eye of one of the interceptor traps on the drains experimented upon, revealed the fact that by the omission of the trap, the sewer air containing dangerous pathogenic germs passed freely into the private house drain. This, I submit, proves that it is a most dangerous practice to ventilate sewers *viâ* ventilating pipes or drains, as is done in Grimsby and Torquay, without the interposition of interceptor traps.

Ill-ventilated drains joined to ill-ventilated sewers undoubtedly produce insanitary conditions, which cause epidemics of typhoid and other preventable diseases, as the following extract from a recent issue of the *Western Mail* will exemplify:

"RHYMNEY.

"*Typhoid, Diphtheria, and Sewer Gas.*

"Mr. Thomas Jenkins, J.P., presided. The Medical Officer of Health reported that there had been twenty-eight cases of typhoid fever, and three deaths. He had attributed the fever

in the upper district to sewer gas, through insufficient ventilation of the main sewers, although the drains of a large number of the houses were properly ventilated by pipes reaching above the roof. He was still of opinion that sewer gas was the chief cause, and he recommended that the main sewers be better ventilated. Of diphtheria there were twenty cases. Sewer gas, no doubt, contributed, but was not the chief cause."

The above is only a sample of thousands of similar reports which have been issued from time to time by the Medical Officers of Health in this country; and feeling absolutely confident, as I and my partner do, that by substituting our hydro-mechanical system for the existing inefficient *venting* system of drain and sewer ventilation, an end would be put to such catastrophes as occurred at Rhymney, we must be pardoned for condemning every system of ventilation which is not in accord with sound scientific and sanitary principles. I believe, moreover, that instead of the initial and annual costs which the Torquay and Grimsby plans of imperfectly ventilating the private drains and the public sewers being less, will, if anything, be more than the initial and annual costs attendant upon the adoption of our Hydro-Mechanical plans of ventilation.

I have to thank Mr. Whyatt of Grimsby, on the one hand, and Mr. Hayward of Battersea, on the other, for drawing the attention of those interested in the subject of sewer ventilation, to the fact that sewers which are the recipients of both sewage and rain-fall at times are inundated, when, of course, house drains on such occasions are inundated also, and the sensitive reflux air valve fixed above the house drain interceptor, as shown in Drawings Nos. 2 and 3, might then be submerged in sewage waters, in which event the reflux air valve might be disarranged, and would not afterwards—*pro tem.*, at least—work properly. But where sewers and drains are liable to be flooded, the air inlet and reflux valve should be fixed, as it always could be inexpensively fixed, above the highest flood-level mark in the house-drain interceptor inspection chamber; or the valve box, etc., could be fixed high and dry above ground, just as mica flap-valve boxes are placed as illustrated on Drawing No. 1. I am, indeed, very gratified to find that so many members—four of them being ex-presidents of the Association—have taken part in the discussion of my paper, as it is evidence of

the fact that they take a genuine interest in the subject on which it treats, and which, as I stated at the beginning of my paper, I regard as one of supreme importance to the members of your Association—none more so; and this truism, in my opinion, will grow upon you all, including the two members who are apparently opposed to sewer ventilation of any kind whatever, in proportion to the time which each will devote to the study of correct pneumatic principles, by the application of which alone the economical and sanitary ventilation of soil pipes, drains, and sewers can be universally brought about in this and every other country, where the so-called English water-carriage system of sewage removal is in vogue.

NOTES ON TRAMWAY WEAR AND MAINTENANCE.

BY C. F. WIKE, M.INST.C.E., CITY ENGINEER, SHEFFIELD.

SINCE the Annual Meeting in July, 1902, when the writer contributed a paper on Tramway matters, experience in this branch of municipal engineering has considerably advanced, and he returns to the subject not merely to place before the Association particulars relating to a single town, but also with the object of inducing other engineers interested to give similar information, and so arrive at a comparison of figures which may be of general benefit.

As the specification and other particulars relating to the Sheffield tramways have been revised in the mean time, a few further details may not be out of place.

PARTICULARS AS TO SHEFFIELD TRAMWAYS.

The length of tramways is 36 miles of route, equal to nearly 70 miles of single track, and the permanent way cost 442,242*l.* The population served is approximately 450,000. The steepest gradient is about 1 in 9·5, and the sharpest curve has a radius of 38′.

Specification of Rails.—The rails are of British Standard Section No. 5; their length is 60′, and their weight 110 lbs. per yard. The older rails, as to the wear of which statistics are given, were of a different section (see Vol. XXVIII. of "Proceedings," page 256, and accompanying diagram "B"), and weighed 108 lbs. per yard.

The analysis of the rails supplied under the first contract and the present one are given in parallel columns overleaf.

	First contract.	Present contract.
Carbon	0·35 to 0·45 per cent.	0·40 to 0·50 per cent.
Silicon	Not more than 0·1 „	Not more than 0·1 „
Sulphur	„ „ 0·1 „	„ „ 0·08 „
Arsenic	—	„ „ 0·08 „
Phosphorus ...	Not more than 0·06 „	„ „ 0·08 „
Copper	—	„ „ 0·08 „
Manganese ...	—	Not less than 0·70, and not more than 1·10 per cent.
	No other material present except iron and manganese	

The writer, although a Member of the Sub-Committee of the Engineering Standards Committee appointed to deal with tram rails, does not in all respects agree with the Standard Specification. He thinks too great a latitude is given in the analysis and that the mechanical tests specified are not altogether sufficient, therefore, although the Standard Section of rail has been adopted, the Standard Specification is not entirely adhered to.

Joints.—The Standard Specification has also been applied to the fishplates. Each joint is secured with 6 pairs of nuts and bolts, weight about 2½ lbs. per pair, and Ibbotson's lock nuts are used. Except where some special device is adopted, a piece of old rail about 2′ long, inverted, is placed under the joint, riveted to the flange of the running rail. Cross anchors are also used at 20′ intervals. The bonds are of the Crown solid type. The rail ends are placed close together, without any allowance for expansion. Diagram "A" illustrates this rail joint.

A large number of special joints have also been tried, including some which aim at perfect rigidity, others which are designed to give elasticity, welded joints, various anchors, and sleeper construction, as well as the renewable joint plates introduced by Mr. Arthur Brown (City Engineer, of Nottingham), which have only recently been used in Sheffield.

Points and Crossings.—All points and crossings are now of manganese steel. The points are 12′ long, and the crossings are of the "leg" type about 5′ to 6′ long. The points are on the twin movable principle, which may add a little to the first expense, but reduces the bumping and noise as compared

with dummy or open points. Renewable insets for the wearing parts have not been adopted.

Concrete.—The rails are laid and jointed before the concrete is laid, experience showing that by this method there is less likelihood of subsequent loosening, and the concrete is always carried over the flange of the rail. The proportions used are six of broken stone and sand to one of Portland cement, except under the rails, where one part of cement is used to five parts of broken granite and sand.

General Cost of Repairs and Renewals.—Electric traction has been in use in Sheffield for nearly eight years, the town having been one of the earliest to adopt the system, so there is a fair amount of experience available as to the cost of repairs.

The following table shows the cost for each year since the lines were opened :—

Year ending March 25.	Total cost of repairs.	Cost per mile of single track.	Cost per car mile.
	£ s. d.	£ s. d.	Pence.
1900 (7 months)	4 6 7	0 3 2	0·002
1901	1163 5 5	28 8 2	0·148
1902	3042 4 6	60 12 7	0·207
1903	3532 10 10	57 7 7	0·177
1904	8570 8 10	129 2 5	0·356
1905	9456 10 1	139 13 6	0·375
1906	7775 14 4	111 19 5	0·299
1907	7079 3 4	101 9 0	0·249

An explanation is perhaps necessary as to the somewhat sudden rise and subsequent fall in the cost of repairs. This is due first to the fact that some of the routes were laid with tar macadam—a form of construction known at the time to be unsuitable—which has since been replaced. Some of the earlier routes were also for economical reasons laid on old concrete foundations, and these required heavy repairs during the years 1903–4 and 1904–5.

The cost of repairs is, perhaps, not of great value unless also accompanied by figures as to renewals, and these have worked out as follows :—

Year ending March 25.	Total cost of renewals.	Cost per mile of single track.	Cost per car mile.
	£ s. d.	£ s. d.	Pence.
1900 (7 months)	—	—	—
1901	539 1 4	13 3 6	0·068
1902	1,971 12 10	39 5 11	0·134
1903	—	—	—
1904	3,141 9 4	47 6 7	0·131
1905	2,587 13 9	38 4 5	0·102
1906	6,828 9 3	98 10 5	0·263
1907	12,073 15 7	173 4 0	0·425

The expenditure under these headings for the earlier years was trifling. Lately the figures have been increased by the conversion of tar macadam tracks to wood—an item which would not have appeared had the work been carried out at first in a more permanent manner—and now, in the eighth year of the life of the tramways, substantial renewals in the ordinary sense of the word are commencing. Further extensive work is in view for next year, and, this door having been opened, it is difficult to tell when it will again be closed. The tendency is to make the new work more substantial; but, on the other hand (as Column 4 of the accompanying statement shows), the frequency of the car traffic steadily increases, and heavier cars are being used, so that the annual wear and tear are greater.

In comparing the cost of repairs and renewals in different towns, not only should the age of the track and the car mileage be considered, but also the relation of the latter to the length of track. Obviously on a system with heavy traffic (in Sheffield there are annually about 100,000 car miles to each mile of single track) the cost of repairs must be greater than for a system with light traffic. The heavy gradients too are a cause of much greater expense in the matter of repairs and renewals.

However carefully statistics may be prepared, it will still be impracticable to exactly compare one town with another as each has its own peculiar features, and there is also the vehicular traffic to consider. It may be argued that the effect of such traffic on tram-rails is negligible, and the contention may be sound if applied to towns where there is ordinary traffic only. In many of the Yorkshire and Lancashire towns, however, where the loads are heavy and the traffic frequent, the cost of repairs is considerably increased in this way. The rail numbered 1 on diagram "B" had taken very little tramway

traffic; in fact, it formed part of a track not used for any regular service, yet it was worn to such an extent that an accident was caused, and a new rail had to be substituted.

This diagram also shows sections of several worn rails taken up on busy routes, and attention is called to the extraordinary effects of the wear to which they have been subjected. In most cases the groove has widened to a much greater extent than might have been anticipated, and this is attributed largely to the action of the wooden slipper brakes, the rails generally having been taken from tracks with a falling gradient. This is a proof that heavy gradients incur more cost in repairs and renewals. Not only have the brake blocks worn away the rails, but they have also forced the check outwards. The rails of which these are fair specimens were of low carbon, but they have worn very evenly and given good running till the last without showing signs of corrugation. Particulars respecting each rail are given on the accompanying schedule.

Corrugation.—Touching for a moment on this point, although there is a certain amount of corrugation in Sheffield, the trouble has not been so pronounced as in some other towns. Occasionally the corrugations disappear of themselves. When treatment is required, the most hopeful method seems to be by attaching grinding blocks to a car. Discovery of the cause seems as far away as ever, and so far no common factor has been observed. There are corrugations on rising and falling gradients, on straight tracks and curves, on loose rails and rails which are quite rigid, on welded track and track laid on sleepers; it appears in some rails after years of wear, and on others immediately they are in use, nor is it confined to high-carbon or low-carbon rails. In one case it has appeared on rails used as a temporary track, with a very flexible bed, in a few days, although such rails had been under regular and heavy traffic for eight or nine years without any sign of corrugation being noticed.

Special Renewals.—With reference to methods of work, only one or two special cases need be referred to. An interesting renewal now in progress is in South Street Moor. This is a street 600 yards long, the carriage-way of which has an average width of 36′. The daily number of car journeys over each track is approximately 1200, and the work is being done without any suspension or curtailment of the tramway traffic. The old wood blocks having been previously moved, on the night of

Saturday, May 24, the whole of the up track (600 yards) was shifted bodily 6′ 6″ out of its original position to the side of the road, and temporary connections made at either end. The operation occupied about 8 hours, and the full service of cars has since been running over the old track in its temporary position without mishap. Two trenches about 18″ wide and 12″ deep were cut for the whole length of the street through the old concrete, this being necessary on account of the adoption of sleeper construction. New 60′ rails with ends splayed to an angle of 45 degrees were then placed in position on longitudinal wooden sleepers, fished up, and the trenches were filled in with new concrete, this being completed on June 3, or 8 days after moving the old track.

In the mean time the vehicular traffic had been continued over half the width of the street until May 30, when the down track was dealt with in precisely the same way. The new up track was in full use by June 12, and the down track by June 16, or about three weeks after the commencement of the work, and that without disturbing the car traffic.

In his paper five years ago, the Author referred to a special junction of manganese steel which had then been laid a few months. The work was remarkable as being perhaps the most important manganese junction carried out at the time. Not only was it intricate on account of the number of rails and points, but the shape and levels made it all the more difficult. After nearly 6 years' wear, during which period it is calculated there have been about 6 million car journeys, efficient service is still being obtained, but the parts which take the greatest wear are worn out, and in September next the junction, with additional points and curves (diagram "C") is to be relaid (again in manganese steel) at an estimated cost of 2400*l.*

To avoid undue length, the matters referred to in this paper have been dealt with in a brief and, perhaps, summary manner, but any further point which may present itself can be explained in a later communication.

Engineers scarcely seem to have been as fully alive as the managers to the necessity of comparing their results, standardising them, and utilising one another's experience, and it is suggested that if statistics as to the cost of repairs

and renewals could be compiled and published, possibly on the lines of the appended table, it would be an advantage.

The principal object of this paper is to induce other engineers responsible for tramway permanent way also to place their experience and figures at the disposal of the Association, and it is hoped they will express their opinion as to the desirability of standardising and publishing the cost of repairs and maintenance, possibly on some such lines as those indicated.

PARTICULARS AS TO RAILS SHOWN ON DIAGRAM "B."

No. 1. *Blonk Street (Double Track).*
Rail taken up on disused track after little service, but worn by vehicular traffic.
Life of rail, 78 months.
Carbon, 0·35 to 0·45 per cent.

No. 2. *Barber Road (Single Track).*
Gradient, 1 in 11.
Radius of curve, 130 feet.
Life of rail, 92 months.
Car journeys, 766,584.
Carbon in rail, 0·35 to 0·45 per cent.

No. 3. *South Street Moor (Double Track).*
Gradient, 1 in 542.
Radius of curve—straight track.
Life of rail, 93 months.
Car journeys, 2,938,658.
Carbon in rail, 0·35 to 0·45 per cent.

No. 4. *Waingate (Double Track).*
Gradient, 1 in 15.
Radius of curve, 150 feet.
Life of rail, 84 months.
Car journeys, 2,505,208.
Carbon in rail, 0·35 to 0·45 per cent.

No. 5. *Haymarket (Double Track).*
Gradient, 1 in 25.
Radius of curve, 230 feet.
Life of rail, 84 months.
Car journeys, 2,505,208.
Carbon in rail, 0·35 to 0·45 per cent.

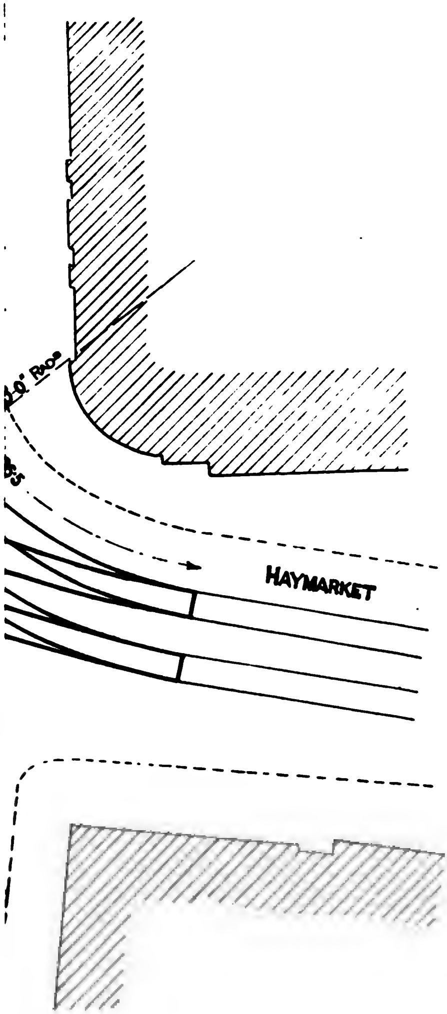
No. 6. *High Street (Double Track).*
Gradient, 1 in 23.
Radius of curve—straight track.
Life of rail, 84 months.
Car journeys, 2,134,561.
Carbon in rail, 0·35 to 0·45 per cent.

SHEFFIELD CORPORATION TRAMWAYS, JUNE 7, 1907.

STATISTICS OF COST OF REPAIRS AND RENEWALS.

Year ending.	Length of track in single miles.	Car mileage.	Car mileage per mile of single track.	Total cost of Repairs.	Total cost of Renewals.	Cost per mile of single track. Repairs.	Cost per mile of single track. Renewals.	Cost per car mile. Repairs.	Cost per car mile. Renewals.	Combined cost of Repairs and Renewals. Total.	Combined cost of Repairs and Renewals. Per mile single track.	Combined cost of Repairs and Renewals. Per car mile.
	m. f. chs.			£ s. d.	£ s. d.	£ s. d.	£ s. d.	Pence.	Pence.	£ s. d.	£ s. d.	Pence.
7 months to March 25, 1900	26 4 8·2	527,292	19,823	4 6 7	—	0 3 2	—	0·002	—	4 6 7	0 3 2	0·092
,, 1901	40 7 3·6	1,886,415	46,100	1,163 5 5	539 1 4	28 8 2	13 3 6	0·148	0·068	1,702 6 9	41 11 8	0·216
,, 1902	50 1 4·0	3,525,999	70,281	3,042 4 6	1,971 12 10	60 12 7	39 5 11	0·207	0·134	5,013 17 4	99 18 6	0·341
,, 1903	61 4 4·9	4,777,146	77,601	3,532 10 10	—	57 7 7	—	0·177	—	3,532 10 10	57 7 7	0·177
,, 1904	66 2 9·9	5,768,231	86,910	8,570 8 10	3,141 9 4	129 2 5	47 6 7	0·356	0·131	11,711 18 2	176 9 0	0·487
,, 1905	67 5 6·4	6,049,899	89,363	9,456 10 1	2,587 13 9	139 13 6	38 4 5	0·375	0·102	12,044 3 10	177 17 11	0·477
,, 1906	69 2 4·9	6,236,561	89,980	7,775 14 4	6,828 9 3	111 19 5	98 10 5	0·299	0·263	14,604 3 7	210 9 10	0·562
,, 1907	69 6 3·0	6,804,655	97,505	7,079 3 4	12,073 15 7	101 9 0	173 4 0	0·249	0·425	19,152 18 11	274 13 0	0·674

DIAGRAM C.



To face p. 392.

DISCUSSION.

Mr. J. R. Findlay: Mr. Wike's paper deals, I think, with one of the most important matters falling to be dealt with by Surveyors. Although attempts have recently been made in various quarters to have the repairs of the tramways transferred to the Tramway Department, no good reason has been brought forward for such a drastic change of policy, and to my mind there is no doubt that work of this sort can best be carried out by the Surveyor's Department, and dual control of the street paving will never prove satisfactory. In the section of Mr. Wike's paper dealing with cost of repairs and renewals it would be advantageous if Mr. Wike would clearly define what constitutes a renewal, and what a repair, but it is to be presumed that when new paving setts are put in, for instance, this will constitute a renewal. The upkeep of the track is, I think, likely to prove one of the most costly and difficult matters in connection with tramways, and it is only now that Engineers are beginning to thoroughly realise this. In Leith we have an exceedingly heavy lorry traffic on certain streets near the docks where the car service is not very frequent, in consequence of which the lorries keep on the tram lines, and, as a result, the best whinstone setts get so much worn alongside the rail, that they last only nine months. Granite setts have also been tried, with better results, but even these lasted only about eighteen months. We have now adopted a new style of chilled blocks, which is giving great satisfaction, and which will apparently make the life of the paving the same as the life of the rail. These blocks are set in pairs, and weigh only 4 lbs. each as compared with the ordinary 4-inch chilled block, which in some cases weighs as much as 21 lbs. The expense is therefore, very much less, being about 800*l.* per mile of single track when laid on the four sides of the rail, and they are more efficient, being free from slipperiness, and having no tendency to work loose. Mr. Wike's suggestion that figures as to the cost of repairs and renewals should be tabulated is an excellent one, and I can only express the hope that it will be adopted.

Mr. H. T. Wakelam: I would add my meed of thanks to Mr. Wike for his lucid and valuable notes on "Tramway wear and Maintenance."

The diagrams of rails showing the gradations of wear on the treads are most interesting and useful, and the tabulated statistics of cost of repairs and renewals will be most valuable in the proceedings of this Association.

Mr. Wike's notes on corrugation are also of much value on a problem connected with tramways and their maintenance. I use the word problem advisedly, as I do not think any true reason has yet been assigned to the cause of the trouble. It may be of some interest to the Members of the Association to learn that in all my travels over the system carried out by us in the County of Middlesex I have not noticed a single length of corrugated rail, although parts of the tramway system have been subjected to very heavy wear for four years past. We may be lucky in this respect, and our troubles in this connection may yet be in store for us.

The analysis of the steel specified by me for rails must be as follows:—Carbon from 0·50 to 0·60 per cent.; manganese from 0·7 to 1·10 per cent.; silicon (maximum) 0·20 per cent.; phosphorus (maximum) 0·08 per cent.; sulpur (maximum) 0·06 per cent.

The high percentage of carbon may account for our immunity from corrugation. All the special work points and crossings used in our scheme are wholly made of the best manganese steel.

I quite agree with Mr. Wike that some sort of publication of the cost of repairs and maintenance of the up-keep of electric tramway systems would be most interesting and useful.

Mr. H. Mattinson: I desire to express my appreciation of Mr. Wikes' paper on tramway wear and maintenance. It is a subject of even more importance to-day than that of construction, and the paper will no doubt throw a light on the effect of certain modes of construction on the cost of the maintenance.

Numerous forms of special joints are mentioned in the paper as having been adopted in Sheffield. It would be instructive if the Author could give the results of the use of each, now or at a later date if a longer period be required for investigation.

As regards the use of manganese steel for points, whilst paying every tribute to manganese steel, I consider its adoption for the whole of the point rather an extravagance, and its value

to lay in the renewable centre plates. The natural object in the design of points and crossings would be to obtain a life equal to that of the adjacent track work, neither more nor less, as one would not care to renew a route with new rails on to largely worn special work. Again, whatever material the point and crossing may be made of, there is a maximum of wear at the intersection of the treads. The advantage of the hardened renewable centres is that such concentrated wear may be met by replacing such centre, and this principle will apply to whatever material the point, etc., is composed of. My experience is that with cast-steel points and iron-bound rail crossings, both having renewable centre plates, the life of the points and crossings is equal to that of the adjacent track, and the bump at the intersection of the treads is avoided by renewing the centres as frequently as required, the cost being relatively a trivial matter. Regarding double switch points, they certainly give easier running, but the cost is a matter for consideration.

To procure costs of track maintenance in a manner that will admit of comparison between different systems is a difficult matter. In the Author's figures he explains that the replacement of tar macadam is included, and similar special repairs must occur in every system. Again, the average cost per mile, whilst useful and interesting as regards the particular system, does not compare with the average of another system where the traffic considerations are different. The cost per car mile seems to be the only unit comparable with all systems, the defect, however, is that the unit is so small. Whatever the unit, both renewals and repairs together are essential. The question of anchoring is still a vexed one, and it would be interesting to hear if the Author has relative costs in maintaining anchored and unanchored track. One great difficulty in connection with anchoring is the trouble which arises when the ground subsides, however slightly, and the rails require a little lifting and packing. These slight subsidences constantly take place on the lines in my charge, and I am impressed with the difficulties that would arise in such instances.

Corrugations are becoming a large item in tramway maintenance both from the necessity of their removal and the disturbance they cause to the road bed and paving. It is noticeable in this connection how slowly the corrugations form in the wet seasons, whilst they appear in a very short time in

dry weather. I have noticed that wherever a crossing or a depression at a joint occurs, a similar depression commences to form in the opposite rail of the track, even though such rail be quite continuous at such point. I would suggest as useful information, records of the approximate number of cars that have passed over lines with the corresponding depth of wear on the rail. This would enable an estimate to be made of the probable life of a route under a given service. Vehicular traffic has undoubtedly a wearing effect on the rail, which is relatively larger on lines having a small service to those with a frequent service. The effect of this, however, on lines of average service might be neglected.

COMMUNICATED REPLY.

Mr. Wike: In Mr. Findlay's contribution I am pleased to note he refers to the question of who should control Tramway Permanent Way. It seems to me that if the matter is fairly and thoroughly considered there can be no doubt as to the answer—that the responsibility should remain with the engineer. One strong reason is that the Tramways are part of the Highways, and few will be bold enough at this time to suggest that these ought to be under dual control. Another is that the manager is, or should be, first and foremost a commercial man, and the upkeep of the track—which, as Mr. Findlay puts it, is likely to prove one of the most costly and difficult matters in connection with tramways—should have the benefit of the special training and technical knowledge of the engineer. Mr. Findlay inquires as to the dividing line between repairs and renewals: broadly speaking, when new materials are used the cost is debited to "renewals," when it is simply a question of repair, the cost is charged accordingly. It is difficult to lay down an absolute line of division, the matter is one where discretion must come in. What he says as to the wear caused by vehicular traffic along the tram rails agrees with my experience, but the wear has not been so rapid with us; possibly we have used a harder granite.

In reply to Mr. Wakelam's remarks as to the immunity from corrugation of the County of Middlesex Tramways, our experience in Sheffield was that for several years corrugation was entirely absent, but in later years it has appeared in many

places, a fact which gives colour to the contention of many engineers that this trouble is due to the worn gearing of the cars. Though this theory seems a reasonable one I would not like at present to identify myself with it.

Mr. Mattinson asks the result of our trials of experimental joints. One of the difficulties of these experiments is that, if the joint is at all a good one, many years must elapse before a thorough comparison can be made between it and other good types of joints, therefore the time has not arrived when a full comparison can be made. Respecting the use of manganese steel for points, we have lately got in tenders for both manganese steel and for the type of point which Mr. Mattinson prefers. We have, however, found the price of the latter somewhat higher. Inquiries I have made from engineers as to renewable centre plates show there is often a difficulty in effecting the renewal, and I believe their use is only on a small scale. The extra cost of double-switch points compared with the old-fashioned dummies does not seem to me serious compared with the more efficient results obtained. I have experienced no difficulty such as Mr. Mattinson mentions through anchoring. Cases of subsidence of foundation have been exceedingly rare and on a very small scale. Possibly the difference in our experience in this respect is due to the track which Mr. Mattinson has in his charge not being concreted right across. Lastly, with regard to corrugations, I have not found the result so serious as Mr. Mattinson appears to have done, but perhaps the experience in Sheffield has been more fortunate. What he says as to depressions forming in rails opposite the crossings is quite correct.

In conclusion, I would like to emphasise the suggestion already made, that other engineers should tabulate and publish the cost of track repairs, information that would be of great general use.

BUILDING LAWS OF AMERICAN *versus* BRITISH CITIES.

By ERNEST R. MATTHEWS, Assoc.M.Inst.C.E., F.R.S.E.
Borough Engineer, Bridlington.

The Author in this Paper has endeavoured to set forth in a tabulated form as far as possible the salient points in connection with the Building Regulations of the principal cities of the United States of America, and also of some of the chief cities and county boroughs of this country, and to show that the regulations in the former are far more stringent than in the latter, and to draw attention to many of the American clauses which in his opinion might with great advantage be adopted in this country, especially referring to those Regulations which concern foundations, public buildings, steel skeleton construction, and reinforced concrete structures. In the opinion of the Author the building regulations of our cities are nearly half a century behind those of the American cities. The regulations of the following American cities are referred to in this Paper: Buffalo, Chicago, New York, Philadelphia, and Providence, and of the following British cities and county boroughs: Birmingham, Brighton, Bournemouth, Hull, Leeds, Manchester, Newcastle-on Tyne, St. Helens, and Sunderland; the London Building Act, 1894, The London Building Acts (Amendment) Act, 1905, and the regulations generally of the London County Council are also referred to. The Author is indebted to the City Engineers of most of the before-named cities, and to the Chief Building Inspectors of the remaining cities, and to the Superintending Architect of the London County Council for copies of their regulations which they have kindly forwarded to him.

He has divided his Paper up under the following headings:—Foundations, public buildings, domestic buildings, warehouses

and factories, steel skeleton construction, reinforced concrete structures.

1. *Foundations.*—No clauses in any code of building laws should be considered of greater importance than those relating to "foundations," but, unfortunately, in the building byelaws of our cities this important item is practically ignored, a general clause only being usually inserted similar to that which occurs in the Manchester Regulations, 1902, p. 13, which is as follows:—

"Every person who shall erect a new building shall cause the footings of every wall of such building to rest on the solid ground or upon a sufficient thickness of good concrete, or upon some solid and sufficient substructure as a foundation."

In the Author's opinion, such a clause as this is altogether too indefinite, and is practically useless.

The London County Council Byelaws made under section 16 of the Metropolis Management and Building Acts Amendment Act, 1878, go a little further than this, and specify that concrete under walls shall be at least 9 inches thick, and 4 inches wider than the footings on each side, and that, if natural gravel site, concrete may be omitted with the approval of the Surveyor.

"Composition of lime concrete shall be 1 to 6 of ballast, and cement concrete 1 to 8 of ballast."

But even this clause is, in the opinion of the Author, most indefinite, and very unsatisfactory.

The Author has carefully perused the building bye-laws of a number of our cities and county boroughs, the results of his investigations respecting "Foundations" being that no regulations were in force respecting the maximum load allowable on natural foundations, neither were there any regulations respecting piled foundations, or the maximum load allowable on concrete or brick foundations; the only clauses that he could find respecting foundations being the usual ones relating to width and depth of footings. The building bye-laws of the following cities and county boroughs were those that the Author referred to:—Birmingham, Bournemouth, Brighton, Hull, Leeds, London County Council, Manchester, Newcastle-on-Tyne, St. Helen's, and Sunderland.

In American cities, however, the regulations respecting foundations are very stringent. The clauses including—

(*a*) The maximum weight per super. foot allowable on various soils.

(b) Maximum weight allowable on concrete foundations.

(c) Maximum weight allowable on brickwork foundations.

(d) Maximum weight allowable on reinforced concrete foundations. (This item is dealt with by the Author under the heading, "Reinforced Concrete Structures.")

(e) Maximum weight allowable on piles.

These are given briefly in the three following tables:—

AMERICAN REGULATIONS RESPECTING THE BEARING POWER OF SOILS.

ALLOWABLE PRESSURE PER SQUARE FOOT.

	Natural compact earth, safe load per square foot.	Clay, safe load per square foot.	Dry sand, safe load per square foot.	Clay and sand 15 ft. or more thick.
Chicago Building Laws, 1906		If dry clay 15 ft. or more thick, 2 tons	If sand is 15 ft. or more thick, 1·8 tons	1·5 tons
New York Building Laws	4 tons			
Philadelphia Building Laws		Dry, hard clay, 3·5 tons		Sand and loose gravel, 3·5 tons
Buffalo Building Laws, 1906		Dry, hard clay, 3·5 tons		Sand and loose gravel, 3·5 tons

AMERICAN REGULATIONS RESPECTING CONCRETE AND BRICKWORK FOUNDATIONS FOR BUILDINGS.

ALLOWABLE PRESSURE PER SQUARE FOOT.

	Allowable pressure per square foot.	Brickwork in cement mortar.	Brickwork in lime mortar.	Brickwork in lime and cement mortar.
Philadelphia Building Laws	15 tons	15 tons	8 tons	12 tons
Chicago Building Laws, 1906	11 tons	11 tons	5·8 tons	
Buffalo Building Laws, 1906	4 tons, but increased if concrete foundation is of a good depth	5 tons (common bricks); 12 tons (pressed bricks)	3 tons (common bricks); 6 tons (pressed bricks)	9 tons (pressed bricks)

AMERICAN REGULATIONS RESPECTING PILED FOUNDATIONS FOR BUILDINGS.

NOTE.—The Building Laws of the American cities clearly state that piling must be resorted to if the soil is very sandy or loose, the piles used in America being generally of spruce.

ALLOWABLE LOAD ON PILES.

Regulations of the city of	Diameter at smaller end of pile.	Head.	Spaced centre to centre.	Load allowed on each pile.	Remarks.
New York	5 inches		Not over 30 inches	20 tons	
Chicago, 1906				25 tons	Driven to rock or hard pan bearings
NOTE.—No greater load allowed on concrete piles.					
Philadelphia	5 inches	12 inches	Not over 30 inches	18 tons	
Buffalo, 1906	6 inches		Not over 36 inches	25 tons	

The clauses relating to "Foundations" contained in the Building Laws of the City of Buffalo, U.S.A., 1906, are as follows:—

Foundations.

Sec. 74.—"Foundations shall be proportioned to the actual average loads they will have to carry in the completed and occupied building, and not to theoretical or occasional loads.

"Foundations shall be constructed of either of the following:—Cement, concrete, dimension or rubble stones, iron or steel beams or rails, timber piles, or a grillage of oak timber, it being provided, however, that no timber shall be used in connection with any foundation *at a higher level than that of a permanent saturation.*

Sec. 75.—"Where pile foundations are used, borings of the soil shall first be made to determine the position of the underlying stratum of hard clay or rock, and the piles shall be made long enough to reach hard clay or rock, and they shall be driven down to reach the same, and such pile shall not be loaded more than twenty-five (25) tons to each pile. Piles

must not be less than six (6) inches in diameter at the small end, nor less than twelve (12) inches at the large end; they shall be of sound oak timber, or timber of equal strength, and shall not be driven more than three (3) feet apart from centre to centre, nor closer together than two (2) feet from centre to centre.

"The tops of all piles shall be cut off below the lowest water line. When required, concrete shall be rammed down in the interspaces between the heads of the piles to a depth and thickness of not less than twelve (12) inches and for one (1) foot in width outside of the piles. Where ranging and capping timbers are laid on piles for foundations, they shall be of hard wood not less than six (6) inches thick and properly joined together, and their tops laid below the water line. In all cases the timber cappings shall be so proportioned that in the transmission of strains from pile to pile the extreme fibre strain in the timbers composing the grillage shall not be more than twelve hundred (1200) pounds to the square inch.

Sec. 76.—"All buildings over seventy-two (72) feet in height, shall have at least three (3) rows of piles under the foundation where piles are required.

Sec. 77.—"Foundations, except for buildings of Class 3, shall not be laid on filled or made ground, and no foundations shall be laid on any soil containing admixture of organic matter.

Sec. 78.—"If steel or iron rails or beams are used as parts of foundations, they must be thoroughly imbedded in concrete, the ingredients of which must be such that after proper ramming, the interior of the mass will be free from cavities. The beams or rails must be entirely enveloped in cement mortar not less than one (1) inch thick. Any cement may be used equal to Standard called for in Sect. 83.

Sec. 79.—"If concrete foundations are used by themselves and without the insertion of iron or steel beams or rails, the offsets on top of same shall not be more than one-half the height of the respective courses, and the narrowest course of such concrete foundation must not be loaded more than eight thousand (8000) pounds per square foot. The first or bottom course must not be less than twelve (12) inches thick. If reinforced by iron or steel rails or beams, the load and offsets in the same must be so adjusted that the fibre strain upon the metal, if iron, shall not exceed twelve thousand (12,000) pounds

per square inch; or if steel, that the fibre strain shall not exceed sixteen thousand (16,000) pounds per square inch.

Sec. 80.—"Dimension stones must have uniform beds, and the offsets in the same, where two (2) or more layers are used, must not be more than three-quarters of the height of the individual stones. They must be set with full beds of cement mortar under their entire areas, and in such manner that they will not rock after being set. Dimension stone in foundations shall not be subject to a load of more than twelve thousand (12,000) pounds per square foot. If the beds of the stones are dressed and levelled off to uniform surface, and stones are set in Portland cement mortar, this strain may be increased to fourteen thousand (14,000) pounds per square foot.

Sec. 82.—"Foundations must, in all cases, extend at least four (4) feet below the surface of the ground upon which they are built, provided that sound, hard soil is found at that depth; if not, they must be carried to sound, hard soil. In all cases a connection with the street sewer shall be established before beginning the work of laying foundations, and where foundations are built in wet soil, it shall be unlawful to build the same unless the trenches in which the work is being executed are kept free from water by draining, bailing, pumping, or otherwise, if such is possible, until after the completion of work upon the foundations.

Sec. 83.—"The cement to be used in concrete footings for all buildings over 52 feet in height shall be a Standard Cement, which must be approved by the Deputy Building Commissioner.

"Cement must be kept dry, and must be used fresh from the package; cement which has been permitted to become wet, hard, or lumpy before it is mixed into the mortar or concrete, shall not be used. Cement mortar for concrete shall be made in the proportions of one (1) of cement (quality equal to that before described) to three (3) parts sand mixed dry and then tempered with water. Enough of this mortar shall be used to completely fill the interstices between the stones. The use of concrete or mortar of all kinds, the ingredients of which are not thoroughly and completely mixed, and which are not free from lumps or other unmixed portions of the ingredients, is prohibited; and also the use of cement mortar which has become partly or wholly set before use. Concrete foundations, where-ever used, must have boxes of plank all around them, and the

concrete must be well rammed in individual layers not more than six (6) inches each in thickness. The ramming must be continued until the water stands on the top of the mass of concrete.

"Stone used for making concrete for foundations must be clean and free from dirt and dust, and must be broken to pass through a two (2) inch ring. All sand must be free from admixture of loam, and must be otherwise clean and sharp."

The Author is of the opinion that it would be well if the whole of the above clauses (with slight modifications) were inserted in the Building Regulations of our cities.

(2) *Public Buildings (Theatres, Music-halls, etc.).*—The regulations in force in our large cities and boroughs (with the exception, perhaps, of the Metropolis), respecting the erection of public buildings are very vague, and altogether insufficient to secure the safety and convenience of the public. In most of our cities no special regulations are in force dealing with the erection of such buildings.

On referring to the bye-laws of the before-named cities and county boroughs, the Author found that the only clauses relating to public buildings were the usual ones dealing with—thickness of walls, strength of joists, roof timbers, etc., and which clauses apply also to buildings of the warehouse class. In some of these bye-laws clauses relating to ingress and egress, and ventilation, also appear.

It will be seen from this that there is room in this country for great improvement in respect to the regulations relating to important buildings of this kind. The regulations of the London County Council, contained chiefly in the Metropolis Management and Building Act Amendment Act, 1878, go more fully into the matter, but are far from up to date and might be greatly improved.

In American cities the building laws deal very fully with buildings of this class, and are very stringent. The subjects dealt with including such important items as corridors, exits and entrances, balconies, staircases, location of storage rooms, dressing rooms, the construction of proscenium and proscenium openings, skylights, fireproof curtain, fly galleries, roof, floors, galleries, seats, width of aisles, capacity of lobbies, location of steam boilers, heating apparatus, stand pipes, fire extinguishing apparatus, tower fire escapes, lighting appliances, thickness of

walls, construction of roof gardens, construction of stage, scenery, footlights, and foundations.

The regulations in force respecting the erection of Public Halls and Assembly Rooms are not quite so stringent. Many of the clauses just referred to, are, in the Author's opinion, very important ones, and show a great advance on the antiquated regulations of our cities.

Before leaving the subject of Theatres and Public Buildings, the Author would draw attention to a very important clause in the Philadelphia regulations, which is as follows:—

Tower Fire Escapes.—"All places of Public Assembly or resort shall have, in addition to the main stairs or other means of egress, a tower fire escape, or escapes, as set forth in the following schedule:—

BUILDINGS OF THE FIRST CLASS.

One Tower Fire-escape.		Two Tower Fire-escapes.
Number of stories in height.	Maximum area per floor in square feet.	Area per floor in square feet.
3 or 4	20,000	Over 20,000 to 25,000
5	15,000	„ 15,000 „ 25,000
6	12,000	„ 12,000 „ 25,000
7	10,000	„ 10,000 „ 22,000
8	9,000	„ 9,000 „ 20,000
9	8,000	„ 8,000 „ 18,000
10	7,500	„ 7,500 „ 17,000
11	7,000	„ 7,000 „ 16,000
12	6,500	„ 6,500 „ 15,000

BUILDINGS OF THE SECOND AND THIRD CLASSES.

One Tower Fire-escape.		Two Tower Fire-escapes.
Number of stories in height.	Maximum area per floor in square feet.	Area per floor in square feet.
3	10,000	Over 10,000 to 15,000
4	6,000	„ 6,000 „ 12,000
5	4,500	„ 4,500 „ 10,000
6	3,500	„ 3,500 „ 8,000

"Buildings of the first class are those which are of 'fire-proof' construction. Those of the second class are those which are of 'slow burning' construction.

"Those of the third class include all buildings, the walls of which are as hereinbefore specified for buildings of the first class, but which in their interior construction are not in accordance with the requirements as hereinbefore set forth for buildings of the first and second classes, or the floors of which may be of ordinary house or joist construction."

(3) *Domestic Buildings.*—The American Regulations relating to the erection of ordinary domestic buildings, and Clauses relating to air space required, and Sanitary Clauses, correspond very largely with those in force in this country (except that the latter clauses are not so stringent as in this country), so that the Author does not intend to deal with this part of the subject, except to show by the following paragraphs the variation in respect of the thickness of walls required for Domestic Buildings under American and English Building Laws.

CHICAGO BUILDING LAWS (1906).

Thickness of Walls (Domestic Buildings).

Basement and one story, 12 and 8 inches respectively; basement and two stories, 12, 12, and 8 inches respectively; basement and three stories, 16, 12, 12, and 12 inches respectively; basement and four stories, 20, 16, 16, 12, and 12 inches respectively: basement and five stories, 20, 16, 16, 16, 12, and 12 inches respectively; basement and six stories, 20, 20, 16, 16, 16, 12, and 12 inches respectively; basement and seven stories, 24, 24, 20, 20, 16, 16, 12, and 12 inches respectively; basement and eight stories, 24, 24, 24, 20, 20, 16, 16, 12, and 12 inches respectively; basement and nine stories, 28, 24, 24, 20, 20, 20, 16, 16, 12, and 12 inches respectively; basement and ten stories, 28, 24, 24, 24, 20, 20, 20, 16, 16, 12, and 12 inches respectively; basement and eleven stories, 28, 28, 24, 24, 24, 20, 20, 20, 16, 16, 12, and 12 inches respectively; basement and twelve stories, 32, 28, 28, 24, 24, 24, 20, 20, 20, 16, 16, 12, and 12 inches respectively.

Note.—In steel skeleton construction, if the building is fireproof, the thickness of walls need not exceed 12 inches.

Regulations of the City of Birmingham.

Thickness of walls. Domestic Buildings. Up to 25 *feet high.*

(*a*) Where the wall does not exceed 25 feet in height its thickness shall be as follows:—

If the wall does not exceed 30 feet in length it shall be $8\frac{1}{2}$ inches thick for its whole height.

If the wall exceeds 30 feet in length it shall be 13 inches thick for the height of one story, and $8\frac{1}{2}$ inches for the rest of its height.

Up to 30 *feet high.*

(*b*) Where the wall exceeds 25 feet, but does not exceed 30 feet in height, its thickness shall be as follows:—

If the wall does not exceed 35 feet in length it shall be 13 inches thick for the lower story and $8\frac{1}{2}$ inches thick for the rest of its height.

If the wall exceeds 35 feet in length it shall be 13 inches thick for the two lower stories and $8\frac{1}{2}$ inches thick for the rest of its height.

Up to 40 *feet high.*

(*c*) Where the wall exceeds 30 feet, but does not exceed 40 feet in height, its thickness shall be as follows:—

If the wall does not exceed 35 feet in length it shall be 13 inches thick below the topmost story, and $8\frac{1}{2}$ inches thick for the rest of its height.

If the wall exceeds 35 feet in length it shall be 17 inches thick for the height of one story, then 13 inches thick for the rest of its height below the topmost story, and $8\frac{1}{2}$ inches thick for the rest of its height.

Up to 50 *feet high.*

(*d*) Where the wall exceeds 40 feet, but does not exceed 50 feet in height, its thickness shall be as follows:—

If the wall does not exceed 30 feet in length it shall be 17 inches thick for the height of one story, then 13 inches thick for the rest of its height below the topmost story, and $8\frac{1}{2}$ inches thick for the rest of its height.

If the wall exceeds 30 feet, but does not exceed 45 feet in

length, it shall be 17 inches thick for the height of two stories, then 13 inches thick for the rest of its height.

If the wall exceeds 45 feet in length it shall be 21½ inches thick for the height of one story, then 17 inches thick for the height of the next story, and then 13 inches thick for the rest of its height.

Up to 60 *feet high.*

(*e*) Where the wall exceeds 50 feet, but does not exceed 60 feet in height, its thickness shall be as follows:—

If the wall does not exceed 45 feet in length it shall be 17 inches thick for the height of two stories, and 13 inches thick for the rest of its height.

If the wall exceeds 45 feet in length it shall be 21½ inches thick for the height of one story, then 17 inches thick for the height of the next two stories, and then 13 inches thick for the rest of its height.

Up to 70 *feet high.*

(*f*) Where the wall exceeds 60 feet, but does not exceed 70 feet in height, its thickness shall be as follows:—

If the wall does not exceed 45 feet in length it shall be 21½ inches thick for the height of one story, then 17 inches thick for the height of the next two stories, and then 13 inches thick for the rest of its height.

If the wall exceeds 45 feet in length it shall be increased in thickness in each of the stories below the uppermost two stories by 4¼ inches (subject to the provisions hereinafter contained respecting distribution in piers).

Up to 80 *feet high.*

(*g*) Where the wall exceeds 70 feet, but does not exceed 80 feet in height, its thickness shall be as follows:—

If the wall does not exceed 45 feet in length it shall be 21½ inches thick for the height of one story, then 17 inches thick for the height of the next three stories, and 13 inches thick for the rest of its height.

If the wall exceeds 45 feet in length it shall be increased in thickness in each of the stories below the uppermost two stories by 4¼ inches (subject to the provisions hereinafter contained respecting distribution in piers).

Up to 90 *feet high.*

(*h*) Where the wall exceeds 80 feet, but does not exceed 90 feet in height, its thickness shall be as follows:—

If the wall does not exceed 45 feet in length it shall be 25½ inches thick for the height of one story, then 21½ inches thick for the height of the next story, then 17 inches thick for the height of the next three stories, and then 13 inches thick for the rest of its height.

If the wall exceeds 45 feet in length it shall be increased in thickness in each of the stories below the uppermost two stories by 4¼ inches (subject to the provisions hereinafter contained respecting distribution in piers).

Up to 100 *feet high.*

(*i*) Where the wall exceeds 90 feet, but does not exceed 100 feet in height, its thickness shall be as follows:—

If the wall does not exceed 45 feet in length it shall be 25½ inches thick for the height of one story, then 21½ inches thick for the height of the next two stories, then 17 inches thick for the height of the next three stories, and then 13 inches thick for the rest of its height.

If the wall exceeds 45 feet in length it shall be increased in thickness in each of the stories below the uppermost two stories by 4¼ inches (subject to the provisions hereinafter contained respecting distribution in piers).

Note.—With one or two slight modifications, the foregoing regulations also represent those of the London County Council as contained in the London Building Act, 1894.

(4) *Warehouses and Factories.*—(Steel framework and Reinforced Concrete Structures the Author deals with under separate headings.) The Regulations in American cities respecting structures of this kind correspond largely with those in force in this country; there is a slight variation however in the "thickness of walls" clauses, as will be seen from the following paragraphs which set out the Regulations in force in Chicago and Birmingham respectively.

CHICAGO BUILDING LAWS (1906.)

THICKNESS OF WALLS (WAREHOUSES AND FACTORIES).

Basement and one story, 12 and 12 inches respectively; basement and two stories, 16, 12, and 12 inches respectively; basement and three stories, 16, 16, 12, and 12 inches respectively; basement and four stories, 20, 20, 16, 16, and 12 inches respectively; basement and five stories, 24, 20, 20, 16, 16, and 16 inches respectively; basement and six stories, 24, 20, 20, 20, 16, 16, and 16 inches respectively; basement and seven stories, 24, 20, 20, 20, 20, 16, 16, and 16 inches respectively; basement and eight stories, 24, 24, 24, 20, 20, 20, 16, 16, and 16 inches respectively; basement and nine stories, 28, 24, 24, 24, 20, 20, 20, 16, 16, and 16 inches respectively; basement and ten stories, 28, 28, 28, 24, 24, 24, 20, 20, 20, 16, and 16 inches respectively; basement and eleven stories, 28, 28, 28, 24, 24, 24, 20, 20, 20, 16, 16, and 16 inches respectively; basement and twelve stories, 32, 28, 28, 28, 24, 24, 24, 20, 20, 20, 16, 16, and 16 inches respectively.

NOTE.—In steel skeleton construction, if the building is fireproof, the thickness of the walls need not exceed 12 inches.

REGULATIONS OF THE CITY OF BIRMINGHAM.

Thickness of Walls. Warehouses and Factories.

18. Every person who shall erect a new public building or a new building of the warehouse class, shall construct every external wall and every party wall of such building in accordance with the following rules; and in every case the thickness prescribed shall be the minimum thickness of which any such wall may be constructed, and the several rules shall apply only to walls built of good bricks, not less than 8½ inches long, or of suitable stone or other blocks of hard and incombustible substance, the beds or courses being horizontal:—

Up to 9 feet high.

(*a*) Where the wall does not exceed 9 feet in height and 30 feet in length it shall be 8½ inches thick for its whole height.

(*b*) Where the wall does not exceed 9 feet in height but exceeds 30 feet in length it shall be 13 inches thick at its base.

Up to 25 feet high.

(*c*) Where the wall exceeds 9 feet in height, but does not exceed 25 feet in height (whatever is its length), it shall be 13 inches thick at its base.

Up to 30 feet high.

(*d*) Where the wall exceeds 25 feet, but does not exceed 30 feet in height, it shall be at its base of the thickness following:—

If the wall does not exceed 45 feet in length it shall be 13 inches thick at its base.

If the wall exceeds 45 feet in length it shall be 17 inches thick at its base.

Up to 40 feet high.

(*e*) Where the wall exceeds 30 feet, but does not exceed 40 feet in height, it shall be at its base of the thickness following:—

If the wall does not exceed 30 feet in length it shall be 13 inches thick at its base.

If the wall exceeds 30 feet, but does not exceed 60 feet in length, it shall be 17 inches thick at its base.

If the wall exceeds 60 feet in length it shall be 21½ inches thick at its base.

Up to 50 feet high.

(*f*) Where the wall exceeds 40 feet, but does not exceed 50 feet in height, it shall be at its base of the thickness following:—

If the wall does not exceed 40 feet in length it shall be 17 inches thick at its base.

If the wall exceeds 40 feet, but does not exceed 70 feet in length, it shall be 21½ inches thick at its base.

If the wall exceeds 70 feet in length it shall be 25½ inches thick at its base.

Up to 60 feet high.

(*g*) Where the wall exceeds 50 feet, but does not exceed 60 feet in height, it shall be at its base of the thickness following:—

If the wall does not exceed 45 feet in length it shall be 21½ inches thick at its base.

If the wall exceeds 45 feet in length it shall be 25½ inches thick at its base.

Up to 70 feet high.

(*h*) Where the wall exceeds 60 feet, but does not exceed 70 feet in height, it shall be at the base of the thickness following:—

If the wall does not exceed 45 feet in length it shall be 21½ inches thick at its base.

If the wall exceeds 45 feet in length it shall be increased in thickness from the base up to within 16 feet from the top of the wall by 4¼ inches (subject to the provisions hereinafter contained respecting distribution in piers).

Up to 80 feet high.

(*i*) Where the wall exceeds 70 feet, but does not exceed 80 feet in height, it shall be at its base of the thickness following:—

If the wall does not exceed 45 feet in length it shall be 21½ inches thick at its base.

If the wall exceeds 45 feet in length it shall be increased in thickness from the base up to within 16 feet from the top of the wall by 4¼ inches (subject to the provisions hereinafter contained respecting distribution in piers).

Up to 90 feet high.

(*j*) Where the wall exceeds 80 feet, but does not exceed 90 feet in height, it shall be at its base of the thickness following:—

If the wall does not exceed 45 feet in length it shall be 25½ inches thick at its base.

If the wall exceeds 45 feet in length it shall be increased in thickness from the base up to within 16 feet from the top of the wall by 4¼ inches (subject to the provisions hereinafter contained respecting distribution in piers).

Up to 100 feet high.

(*k*) Where the wall exceeds 90 feet, but does not exceed 100 feet in height, it shall be at its base of the thickness following:—

If the wall does not exceed 45 feet in length it shall be 25½ inches thick at its base.

If the wall exceeds 45 feet in length it shall be increased in thickness from the base up to within 16 feet from the top of the wall by 4¼ inches (subject to the provisions hereinafter contained respecting distribution in piers).

Thickness of Walls—16 *feet from top to be* 13 *inches thick.*

(*l*) The thickness of the wall at the top, and for 16 feet below the top, shall be 13 inches thick, and the intermediate parts of the wall between the base and 16 feet below the top shall be built solid throughout the space between straight lines drawn on each side of the wall and joining the thickness at the base to the thickness at 16 feet below the top.

Walls under 30 *feet high—Top story* 8½ *inches.*

Nevertheless, in walls not exceeding 30 feet in height the walls of the topmost story may be 8½ inches thick, provided the height of that story does not exceed 11 feet.

Story exceeding fourteen times thickness of walls.

(*m*) If any story exceeds in height fourteen times the thickness prescribed for its walls the thickness of each external wall and of each party wall throughout that story shall be increased to one-fourteenth part of the height of the story, and the thickness of each external wall and of each party wall below that story shall be proportionately increased (subject to the provisions hereinafter contained respecting distribution in piers).

Story exceeding 11 *feet in height.*

(*n*) Every external wall and every party wall of any story which exceeds 11 feet in height shall be not less than 13 inches in thickness.

Distribution of Piers.

(*o*) Where by any of the foregoing rules relating to the thickness of external walls and party walls of public buildings, or buildings of the warehouse class, an increase of thickness is

required in the case of a wall exceeding 60 feet in height and 45 feet in length, or in the case of a story exceeding in height fourteen times the thickness prescribed for its walls, or in the case of a wall below that story, the increased thickness may be confined to piers properly distributed, of which the collective widths amount to one-fourth part of the length of the wall. The width of the piers may nevertheless be reduced if the projection is proportionately increased, the horizontal sectional area not being diminished; but the projection of any such pier shall in no case exceed one-third of its width.

NOTE.—With one or two slight modifications, the foregoing regulations also represent those of the London County Council as contained in the London Building Act, 1894.

(5) *Steel Skeleton Construction.*—This form of construction has been largely adopted in America during the past fifteen years, especially for buildings used for the sale, storage, or manufacture of merchandise, public buildings, hotels, offices, large residences, etc. In fact, the United States has been designated "the Home of Steel Construction."

It was some time, however, before erections of this kind were introduced into this country, but since the advantages of skeleton construction have become so well recognised by British architects, erections of this kind have been largely adopted. In perusing the new London Building Acts (Amendment) Act, 1905, the Author was surprised to find no mention of steel skeleton construction; the architect of a building of this class has to adopt the same ridiculous course that he had hitherto done under the London Building Act, 1894, of making his walls equally as thick as if no steel framework was inserted. Such regulations as these are half a century behind the American building laws. Despite our imperfect regulations, however, many important steel skeleton structures have been erected in this country, each of our cities being able to show fine examples of this form of construction.

The new Midland Hotel at Manchester, covering an area of nearly 2 acres, might be cited; the building being 10 stories in height, and containing 480 rooms; the steel skeleton being encased in masonry. Also the British Westinghouse Company's fine works and offices at Manchester, which cover an area of 55 acres; the steel skeleton being encased in brickwork. While, in the Metropolis, the Ritz Hotel,

Piccadilly, and Savoy Hotel extension, are good examples of recent constructions of this kind.

Many other buildings of a similar character might be named, the structures being designed in every instance so that the steel skeleton is capable of carrying the entire dead weight of the walls, roof and floors, the live load, and stresses due to wind pressure, so that it is obviously very unfair that the bye-laws of our large cities and the London Building Regulations should make it necessary for the walls to be constructed so absurdly thick.

The clauses of the 1894 Act are practically only a repetition of those contained in the Metropolitan Buildings Act, 1855, which was framed before mild steel was really known.

The following two tables prepared by Mr. W. Noble Twelvetrees, M.I.Mech.E., and which appeared recently in the magazine known as *Concrete,* are of great interest, because they give, in Table I., a rough comparison of the space occupied by walls in accordance with the 1894 Act, and as amended by the suggestions of the R.I.B.A. (the space occupied by partition walls, staircases, lift wells, and other interior details being ignored); and in Table II., the additional rooms rendered possible by the adoption of the R.I.B.A.'s recommendations, which are really to a large extent on the lines of the American regulations.

TABLE I.

REDUCTION OF FLOOR AREAS BY THIN WALLS AS PROPOSED FOR SKELETON BUILDINGS BY THE ROYAL INSTITUTE OF BRITISH ARCHITECTS, AND THICK WALLS AS REQUIRED BY THE LONDON BUILDING ACT, 1894. (APPROXIMATELY CALCULATED BY A 12-STORY BUILDING, 100 FEET LONG BY 50 FEET WIDE.)

Gross area (A).	Net area with thin walls (B).	Net area with thick walls (C).	Area gained by thin walls (B–C).
60,000	56,360	52,185	4,175

TABLE II.

ADDITIONAL ROOMS RENDERED POSSIBLE BY THE ADOPTION OF THE WALL THICKNESSES PROPOSED FOR SKELETON BUILDINGS BY THE ROYAL INSTITUTE OF BRITISH ARCHITECTS INSTEAD OF THOSE REQUIRED BY THE LONDON BUILDING ACT, 1894.

APPROXIMATELY CALCULATED FOR A 12-STORY BUILDING 100 FEET LONG BY 50 FEET WIDE.

Floor No.	Rooms gained.		Rooms gained.	
	No. per floor.	Size.	No. per floor.	(Alternative) Size.
		ft. ins.		ft. ins.
1	1	24 9 square	2	17 6 square
2	1	22 8 „	2	16 0 „
3	1	22 8 „	2	16 0 „
4	1	20 3 „	2	14 4 „
5	1	20 3 „	2	14 4 „
6	1	17 0 „	2	12 0 „
7	1	17 0 „	2	12 0 „
8	1	17 0 „	2	12 0 „
9	1	14 6 „	2	10 3 „
10	1	14 6 „	2	10 3 „
11	1	14 6 „	2	10 3 „
12	1	14 6 „	2	10 3 „

The American Regulations not only allow for a reduction in the thickness of the walls where Steel Skeleton Construction is adopted, as will be seen by reference to the following paragraphs, but they also deal with such important clauses as the Method of Construction, thickness of plates, riveting, strength of columns, fire protection (this being a very important clause). The Author is of the opinion that the recommendation of the British Fire Prevention Committee that all steel work should be protected from fire by a covering of 2 inches of concrete should be generally adopted and that there should be a Regulation in our Bye-laws to that effect. It will be noticed from the following paragraphs that in America, terra-cotta tiles are largely introduced for this purpose.

Seeing that the Building Laws of our cities are silent in respect of this modern and important method of construction known as "Steel Skeleton Construction," the Author is strongly of the opinion that there is a great necessity for the introduction

into our antiquated Building Codes of clauses similar to those of the American cities, some of which clauses he gives in the following paragraphs:—

AMERICAN REGULATIONS *re* "STEEL SKELETON CONSTRUCTION."

REGULATIONS OF THE CITY OF BUFFALO (1906).

Definition of the Term "Skeleton Construction."—1st part, sec. 45.—"'Skeleton construction' shall apply to all buildings wherein all external and internal loads and strains are transmitted from the top of the building to the foundation by a skeleton or framework of rolled metal."

Method of Construction.—2nd part, sec. 45.—"In such metal framework the beams and girders shall be riveted or bolted to each other at their respective junction points. All pillars shall be made of rolled iron or steel, and their different parts shall be riveted to each other, and the beams and girders resting upon them shall have riveted or bolted connections to unite them with the pillars. No cast-iron lintels shall be used in the construction of skeleton buildings."

Sec. 50, p. 32.—"All iron or steel used as a supporting member of the external construction of any building, and specified to be fire-proofed, shall be protected as against the effects of external changes of temperature and of fire, by a covering of brick, terra-cotta, concrete, or fire-clay tile, completely enveloping said structural members of iron and steel. If of brick, it shall be not less than eight (8) inches thick; if of hollow tile, it shall not be less than six (6) inches thick; and if of hollow concrete blocks or reinforced concrete steel, it shall not be less than six (6) inches thick, and there shall be at least two (2) sets of air-spaces between the iron and steel members and the outside of the hollow tile covering. In all cases the brick, concrete, or hollow tile shall be bedded in mortar close up to the iron or steel members, and all joints shall be made full and solid. Where a skeleton construction is used for the whole or a part of the building, these enveloping materials shall be independently supported on the skeleton frame for each individual story."

Thickness of Walls.—Sec. 46.—"Buildings of skeleton

construction, when the walls are carried by the metal frame, the thickness of outside masonry must not be less than twelve (12) inches, including not more than four (4) inches of hollow brick or tile lining. In buildings of less than ten (10) stories in height, cast-iron columns may be used, in which case the column connections will be bolted. In buildings of less than ten (10) stories where the skeleton construction of the external walls is replaced by walls of masonry of proper and sufficient strength to sustain the weight of the floors and roof imposed on side walls, the interior pillars may be of cast iron."

Cast-iron Columns.—Sec. 47.—"If cast-iron pillars are used, each successive pillar shall be bolted to the one below it by at least four (4) bolts not less than three-quarters of an inch in diameter, and the beams and girders shall be bolted to the pillars. The strength of all columns and posts shall be computed according to formulæ in sections 146 and 153."

Cast-iron.—Sec. 146.—"Cast-iron subjected to crushing strain only, as in bearing plates, may be loaded to the extent of 15,000 pounds per square inch.

"Compression strain on cast-iron shall not exceed 13,000 pounds per square inch.

"Tensile strain on cast-iron shall not exceed 3000 pounds per square inch.

"Cast-iron used for pillars shall be proportioned in accordance with the following formulæ:—

"For round cast-iron columns—

$$S = 14{,}000\ A \div \left(1 + \frac{L^2}{600\ D^2}\right)$$

S = safe load in pounds.
L = length of column in inches.
A = sectional area of column in square inches.
D = diameter of column in inches.

For rectangular cast-iron columns:—

$$S = 14{,}000\ A \div \left(1 + \frac{L^2}{850\ D^2}\right)$$

S = safe load in pounds.
L = length of column in inches.
A = sectional area of column in inches.
D = the side of square column, or the least horizontal dimension of other columns."

Thickness of Metal in Columns.—Sec. 147.—"The minimum thickness of metal in cast-iron columns shall not be less than three-fourths of an inch, and no cast-iron column shall exceed in height thirty times its least horizontal dimension, without having lateral support."

Sec. 148.—"All cast-iron columns shall have their ends turned true and at right angles to their axis, and the ends shall be parallel with each other."

Columns: how tested.—Sec. 149.—"Cast-iron columns shall be thoroughly tested and inspected before being placed in position, and they shall be drilled with one-quarter inch test holes, not less than two in the length, one on the upper and one on the lower surface of the columns, as cast."

Definition of the Term "Fire-proof Construction."—Sec. 49.—"The term 'Fire-proof Construction' shall apply to all buildings in which all parts that carry weights or resist strains are constructed wholly of stone, burnt clay, iron, steel, or concrete, and in which all stairs, partitions, and elevator enclosures and their contents are made entirely of incombustible material, and in which all metallic structural members are protected against the effect of fire by coverings of a material which must be entirely incombustible and a slow heat-conductor. The materials which shall be considered as fulfilling the conditions of fire-proof covering are—First, brick; second, hollow tiles of burnt clay, applied to the metal in a bed of mortar, and constructed in such a manner that there shall be an air-space of at least three-quarters ($\frac{3}{4}$) of an inch by the width of the metal surface to be covered, within the said clay covering; third, porous terra-cotta, which shall be at least two (2) inches thick if hollow, and not less than one and one-quarter ($1\frac{1}{4}$) inches thick if solid, and this shall also be applied direct to the metal in a bed of mortar. In buildings of this type all door or window mullions, whether vertical or horizontal, shall be faced with cast-iron, terra-cotta, or other incombustible material of equal fire-resisting values."

Strength of Plates.—Sec. 51.—"If iron or steel plates are used in each story for the support of this covering within the said story, such plates must be of sufficient strength to carry within the limits of fibre strain for iron and steel elsewhere specified in this ordinance, the enveloping material for the said story, and such plates may extend to within two (2) inches of the exterior of said covering."

Backing for Terra-cotta.—Sec. 52.—"If terra-cotta is used as part of such fire-proof enclosure, it shall be backed up with brick, concrete, or hollow tile; whichever is used being, however, of such dimensions and laid up in such manner that the backing will be built into the cavities of the terra-cotta in such manner as to secure perfect bond between the terra-cotta facing and its backing."

Sec. 53.—"If hollow tile or concrete alone is used for such enclosures, the thickness of the same shall be made in at least two (2) courses, breaking joints with and bonded into each other."

Sec. 54.—"The upper surfaces of all breaks or offsets in external coverings and fillings of walls, as well as the tops of walls, shall be covered with stone, terra-cotta, or fire-clay copings, set in cement mortar, and having lapped joints pointed with cement."

Internal Fireproofing.—Sec. 55.—"The internal structural parts of buildings of the Skeleton Construction shall be fire-proof by coverings of brick, hollow tile, or porous terra-cotta."

Sec. 56.—"In the case of buildings of Class I., the coverings for columns shall be, if of brick or concrete, not less than eight (8) inches thick; if of hollow tile, these coverings shall be in two (2) consecutive layers, each not less than two (2) inches thick. If the fire-proof covering is made of porous terra-cotta, it shall consist of at least two (2) layers not less than two (2) inches thick each, if hollow, and not less than one and one-quarter (1¼) inch thick each, if solid. Whether hollow tile or porous terra-cotta is used, the two (2) consecutive layers shall be so applied, that neither vertical nor horizontal joints in the same shall be opposite each other, and each course shall be so anchored and bonded within itself as to form an independent and stable structure. In all cases there shall be on the outside of the tiles a covering of plastering, with any cement which is established as a standard cement, or of other mortar of equal hardness and efficiency when set."

Sec. 57.—"In places where there is trucking or wheeling or other handling of packages of any kind the lower five (5) feet of the fire-proofing of such pillars shall be encased in a protective covering, either of sheet iron or oak plank, which covering shall be kept continually in good repair."

Sec. 58.—"In buildings belonging to Class II. the fire-proof

covering for internal columns is to be made the same as specified for the buildings of Classes I. and IV., excepting that only one (1) covering of hollow tile or porous terra-cotta may be used."

Sec. 59.—"The fire-proof covering of iron or steel beams and girders in buildings of Classes I., II., and IV., shall be effected with either of the materials before specified. If hollow tiles or hollow concrete blocks are used, they shall be set close to the metal to be protected; and there shall be an air space within the tile or concrete of at least three-quarters ($\frac{3}{4}$) of an inch. If porous terra-cotta is used, it shall be at least two (2) inches thick, if hollow, and at least one and a quarter ($1\frac{1}{4}$) inch thick, if solid."

Sec. 60.—"If buildings in Class II. are partly used for the purposes of Classes I. and IV., the method of fire-proofing the structural iron or steel in the whole of any story, any part of which is so used, and in the whole of the story above and below the same, shall be as called for in Classes I. and IV."

Sec. 61.—"In all cases the covering of beams shall be so applied as to be supported entirely by the beams or girders protected, and shall be held in place entirely by the support of the flanges of such beams or girders and by the mortar used in setting. Wire binding and anchors shall not be used as fastenings of such fire-proof covering."

Wrought Iron and Steel.—Sec. 150.—"All girders, beams, corbels, brackets, and trusses, if made of steel, shall be so proportioned that the maximum fibre stress will not exceed 16,000 pounds per square inch, or that, if made of iron, the maximum fibre stress will not exceed 12,000 pounds per square inch."

Sec. 151.—"Plate girders shall be designed and constructed of strength at least equal to those developed by the following formulæ:—

"For plate girders—

$$\text{Flange area} = \frac{\text{Maximum bending moment in foot-pounds}}{\text{CD}}$$

D = distance between centres of gravity of flange in feet.
C = 13,500 for steel; 10,000 for iron.

$$\text{Web area} = \frac{\text{Maximum shear}}{\text{C}}$$

C = 10,000 for steel; 8,000 for iron."

Sec. 152.—"Maximum strain per square inch of rivet area (single shear) shall not exceed—

	Steel.	Iron.
For shop-driven rivets	9,000 lbs.	7,500 lbs.
For field-driven rivets	8,000 „	6,000 „
Maximum shearing strain, in webs ...	7,000 „	6,000 „
Direct bearing	15,000 „	15,000 lbs."

Sec. 153.—"The maximum loads allowed upon riveted columns shall not exceed those determined by the following formulæ:—

For riveted or other forms of wrought-iron columns more than 90 R in length—

$$S = 10{,}600 - 30\frac{L}{R}.$$

S = safe loads in pounds per square inch.
L = length of column in inches.
R = least radius of gyration of column in inches."

For riveted or other forms of wrought-iron columns less than 90 R in length—

$S = 8{,}000.$
S = safe load in pounds per square inch.

For riveted or other steel columns more than 90 R in length—

$$S = 17{,}100 - 57\frac{L}{R}.$$

S = safe load in pounds per square inch.
L = length of column in inches.
R = least radius of gyration of column in inches.

For riveted or other steel columns less than 90 R in length—

$S = 12{,}000.$
S = safe load in pounds per square inch."

Sec. 154.—"No wrought-iron or rolled steel columns shall have an unsupported length of more than forty times its least lateral dimensions or diameter, nor shall its metal be less than one-fourth of an inch in thickness."

Sec. 155.—"With regard to connections of all structural iron

work upon buildings erected in the city of Buffalo, such work shall hereafter be in conformity with the practice of the Carnegie, Trenton, Phœnix, Pencoyd, or other first-class rolling mills, as published in their standard books and sheets, and approved by the Deputy Building Commissioner."

Wind Pressure.—Sec. 87.—"In the case of all buildings the height of which is more than one and one-half times their least horizontal dimensions, allowances shall be made for wind pressure, which shall not be figured at less than 30 pounds for each square foot of exposed surface. Where the dead weight of the structure is not sufficient to insure stability against wind pressure, the following precautions must be taken to give the required stability:—

"*First.*—Wrought or steel pillars must be constructed in such manner as to pass through 2 stories with joints breaking in alternate stories.

"*Second.*—Rigid connections must be made between vertical and horizontal members.

"*Third.*—A sufficient quantity of diagonal bracing must be included in the construction to insure absolute stability.

"*Fourth.*—Portal web bracing must be inserted where necessary.

"In buildings deficient in initial stability, the use of cast-iron columns will not be allowed."

NOTE.—The regulations *re* "Steel Construction" of the other chief American cities resemble those given above, so the Author has not included these in the table.

(6) *Reinforced Concrete Structures.*—The extensive use during the past few years of reinforced concrete in building construction in American cities, especially in the heavier classes of construction, such as hotels, factories, warehouses, business premises, and public buildings, has necessitated the formation of very stringent regulations respecting the use of this material. Where not used in the entire construction of a building, it has been employed with very great advantage in certain portions of buildings, such as staircases, projecting galleries, foundations, corbels, vaults, floors, cupolas, etc. In this country ferro-concrete is becoming more and more used, many large warehouses and similar buildings having been constructed throughout of "Reinforced Concrete." The monolithic nature and general rigidity of this material, its durability, cheapness, and last, but

not least, its fire-resisting properties, render its extensive use in all classes of building construction in the near future a certainty. Only recently in Scotland the new cabinet factory of the Singer Manufacturing Company at Kilbowie has been erected by Messrs. Robert McAlpine & Sons, from designs by Mr. Robert Whyte, architect, and this is a fine example of concrete and steel construction. The building is 800 feet long by 80 feet in width, it is 90 feet in height, has six floors, and a cubic capacity of 6,000,000 cubic feet.

The largest reinforced concrete building in the world, however, is the Marlborough Blenheim Hotel, Atlantic City, N.J. This building is erected on the Kahn system of Reinforcement. It is 560 feet long and 125 feet wide; it has nine floors, and the front wing is 15 stories high. The contract was signed in June, 1905, and the entire building was erected, decorated, and finished in eight months, showing that this class of structure can be erected with great rapidity if necessary.

It is the Author's opinion that we are approaching the time when "Reinforced Concrete" and "Steel Skeleton Construction" will be the two principal forms of construction in this country, as in America, for all buildings of the heavier class, hence the need, in his opinion, for the adoption of similar bye-laws to those in use in the chief cities of America. He now gives in the following paragraphs the regulations concerning the use of "Reinforced Concrete" for building construction which are in force in Buffalo. These Regulations being only adopted in 1906, are therefore quite up to date.

Chicago Regulations (1906) are practically the same.

AMERICAN REGULATIONS RESPECTING THE USE OF REINFORCED CONCRETE IN BUILDING CONSTRUCTION.

REGULATIONS OF THE CITY OF BUFFALO, 1906.

Foundations.—Sec. 78, p. 46.—"If steel or iron rails or beams are used as parts of foundations, they must be thoroughly imbedded in concrete, the ingredients of which must be such that after proper ramming, the interior of the mass will be free from cavities. The beams or rails must be entirely enveloped in cement mortar not less than one (1) inch thick. Any cement may be used equal to standard called for in section 83.

"If concrete foundations are reinforced by iron or steel rails

or beams, the load and offsets in the same must be so adjusted that the fibre strain upon the metal, if iron, shall not exceed 12,000 lbs. per square inch; or if steel, that the fibre strain shall not exceed 16,000 lbs. per square inch."

Construction and Thickness of Walls.—Sec. 1*a*, p. 37; also Sec. 2.—"Buildings whose exterior walls are of reinforced concrete may be erected three stories in height, and the thickness of such walls shall be as given in the following paragraphs; provided that the materials of construction are not strained beyond the safe limits elsewhere fixed in these ordinances":—

"*Stories (where basement).*—If one story, 8 inches; if two stories, 10 inches; if three stories 12 inches.

"*Stories (no basement).*—If one story, 6 inches; if two stories, 6 and 6 inches; if three stories, 8, 6, 6 inches."

Clause 2.—"Concrete must be mixed in the proportions of one of Portland cement, two of sand, and five of stone or gravel; or the proportions may be such that the resistance of the concrete to crushing shall not be less than 2000 pounds per square inch after hardening for twenty-eight days. The tests to determine this value must be made under the direction of the Deputy Building Commissioner. The concrete used in reinforced concrete steel construction must be what is usually known as a 'wet mixture.'"

Inspection and Tests.—Sect. 5, p. 38: Sects. 17, 18, p. 41.—"The execution of concrete work shall be confided to workmen who shall be under the control of a competent foreman or superintendent, and persons erecting buildings of concrete shall provide for expert inspection of the cement and inerts, and a daily record shall be kept of the tests, the temperature in which the concrete was worked, and all other conditions which may be of importance in the construction, and a certified copy of such record shall be filed with the Deputy Building Commissioner twice each week, or more often if required by him."

Clause 17.—"The contractor must be prepared to make tests on any portion of a building of concrete within a reasonable time after erection, as often as may be required by the Deputy Building Commissioner. The tests must show that the construction will sustain a load of three times that for which it is designed without any sign of failure."

Sect. 18.—"Before permission to erect any structure of

concrete is issued, complete drawings and specifications must be filed with the Bureau of Building, showing all details of the construction, static computation, the size and position of all reinforced rods, stirrups, etc., with a note on all beams and girders, stating the loads for which they are designed, and giving the composition of the concrete."

Definition of "Reinforced Concrete."—Sect. 3, p. 37.—"The term 'Reinforced Concrete' shall be understood to mean an approved concrete mixture reinforced by steel of any shape, so combined that the steel will take up the tensional stresses and assist in the resistance to shear."

Quality of Materials.—Clauses 6 to 8 pp. 38 and 39. Clause 21, p. 41. Clause No. 6. "Only high-grade Portland cement shall be permitted in concrete construction. Such cement, when tested, after one day in air and six days in water, shall develop a tensile strength of at least 500 lbs. per square inch; and after one day in air and twenty-seven days in water, shall develop a tensile strength of at least 600 lbs. per square inch. Other tests as to fineness, constancy, volume, etc., shall be made in accordance with the standard method prescribed by the American Society of Civil Engineers' Committee, as may, from time to time, be directed by the Deputy Building Commissioner."

Clause 7.—"The sand used must be clean, sharp, grit sand, free from loam or dirt."

Clause 8.—"The stone used in the concrete must be clean, broken stone or gravel, of a size that will pass through a ¾-inch ring.

"In case it is desired to use other materials or other kinds of stone, samples of same must be submitted to and approved by the Deputy Building Commissioner."

Sec. 21, p. 41.—"No concrete work shall be done in freezing weather except when the influence of frost is excluded."

Limit of Stress.—Clauses 9 to 11, p. 39. Clause 9.—"Reinforced concrete steel must be so designed that the stresses shall not exceed the following limits:—Extreme fibre stress on concrete in compression, 500 pounds, in shear 50 pounds per square inch. Tensile stress in steel, 16,000 pounds per square inch. Shearing stress in steel, 10,000 pounds per square inch."

Clause 10.—"The adhesion of concrete to steel shall be

assumed to be not greater than the shearing strength of the concrete."

Clause 11.—"The ratio of moduli of elasticity of concrete and steel shall be taken as 1 to 12."

Bending Moments.—Clauses 12 to 16, pages 39 to 40.—Clause 12: "The following assumption shall guide in the determination of the bending moments due to the external forces. Beams and girders shall be considered as simply supported at the ends, no allowance being made for continuous construction over the supports. Floor plates, when constructed continuous, and when provided with reinforcement at top of plate over the supports, may be treated as continuous beams, the bending moment for uniformly distributed loads being taken at not less than WL – 10; the bending moment may be taken WL – 20 in the case of square floor plates which are reinforced in both directions and supported on all sides. The floor plate may be taken as part of the beam or girder in computing its moment of resistance to the extent of not more than ten times the width of that beam or girder."

Clause 13: "The moment of resistance of any reinforced concrete steel construction under transverse loads shall be determined by formulæ based on the following assumptions:—

"(*a*) The bond between concrete and steel is sufficient to make the two materials act together as a homogeneous solid.

"(*b*) The strain in any fibre is directly proportionate to the distance of that fibre from the neutral axis.

"(*c*) The modulus of elasticity of the concrete remains constant within the limits of the working stresses fixed in these ordinances.

"(*d*) The tensile strength of the concrete shall not be considered."

Sec. 14, page 40.—"When the shearing stresses developed in any part of the construction exceed the safe working strength of the concrete, as fixed in these ordinances, a sufficient amount of steel shall be introduced in such a position that the deficiency in the resistance to shear is overcome."

Sec. 15, page 40.—"When the safe limit of adhesion between the concrete and steel is exceeded, some provision must be made for transmitting the strength of the steel to the concrete."

Sec. 16, page 40.—"Reinforced concrete may be used for columns in which the ratio of length to least side or diameter

does not exceed sixteen. The reinforcing rods must be tied together at intervals of not more than the least side or diameter of the column."

Conclusion.—The Author in this Paper has endeavoured to lay before the Members of this Association sufficient particulars of the American Building Regulations to show that these are far more up-to-date than those of our cities, and that they include many important clauses that might with great advantage be included in our Building Bye-Laws; he has also endeavoured to show that our friends across the Atlantic in their Regulations go more fully into the details of construction than we do, and he trusts that this Paper will be of use to the Association in that it may be referred to by Borough Engineers who are assisting in the drafting of new codes of Building Bye-Laws.

COMMUNICATED DISCUSSION.

MR. A. J. PRICE: Every one must regret that time did not permit the discussion of Mr. Matthews' paper, for it was not only interesting but valuable, as showing how far the problem of drafting bye-laws dealing with modern building requirements has been met.

While I share to a great extent Mr. Matthews' admiration for the way in which the Americans have tackled these problems, especially as regards steel structures, reinforced concrete and fireproof construction, I think many of the tables quoted are so vague and present so great a variation as to be valueless as a guide, and only useful as showing what to avoid. Take the regulation respecting the "bearing power of soils," which allows a pressure of 2 tons per square foot on clay in Chicago, and 3·5 tons in Philadelphia and Buffalo. A variation of 75 per cent. is too great to commend itself for adoption here. The difference for clay and sand is greater still, being 1·5 tons to 3·5 tons.

The regulations for concrete and brickwork foundations quoted are absurd, both in the wide variation of the strengths given and the loose terms employed.

What can one think of regulations which allow a pressure on concrete of 15 tons per square foot in Philadelphia, and only 4 tons in Buffalo, and what is meant by a "good depth"

of concrete? It appears to me that the Manchester clause, to which Mr. Matthews objects as being indefinite and practically useless, is much better and more useful, for it is comprehensive without partaking of a cast-iron character. The London County Council bye-law does not appear to me to be so good, though it is certainly more definite. The difficulty is that the 9-inch concrete foundation appears to be applied equally to a bungalow and a sky-scraper.

Take the case of brickwork, which in cement mortar varies from 15 tons per square foot in Philadelphia to 5 tons in Buffalo for common brick, and 12 tons for pressed bricks. As no special brick is mentioned in Philadelphia and Chicago, I presume we are right in assuming that 15 tons and 11 tons are allowed on common brick in these cities to the 5 tons allowed in Buffalo. In brickwork so much depends upon the strength of the brick, the workmanship, the character of the lime, or composition of the cement mortar, that to be of any great value we must know the strength of the brick and the lime or cement mortar. We must distinguish between the fat limes used in many parts of the Midlands, the stone limes used in London, and the hydraulic limes which are found and used in different parts of the country. The London stock brick has a strength only of about one-tenth that of a Staffordshire blue, Accrington plastic, or Ruabon pressed brick. It will also be necessary to distinguish carefully between the use of the term "stock" in the North of England and London. The "stock" brick in the North is a kiln-made pressed brick; in London it is a hand-made brick, burnt in a clamp, differing altogether in strength and appearance.

The tables on "piled foundations" are more in agreement, but spruce is rarely used in this country for piles, and the piles are not usually of so small a size as 5 inches diameter, or circular in shape. Again, they are to be driven to rock or hard pan bearings, but in many parts of this country it is hardly possible to reach the rock, nor is it necessary. Five miles from Lytham, the Lancashire and Yorkshire Railway Company had to build a railway bridge on the Marton Moss. They drove 12 by 12 inch piles, 60 feet long, for the foundation, without reaching the hard ground, but the friction on the side was amply sufficient to prevent any settlement.

The work of the Surveyor is in most cases sufficiently

difficult now, and the determination of the character and strength of the ground is one of his most troublesome and responsible duties.

I experienced this difficulty in the case of a large furniture warehouse which was to be erected on what I knew was peaty ground. I suggested piling the foundation to the architect, who was an A.R.I.B.A. He said a concrete foundation 12 inches deep and 3 feet 6 inches wide was strong enough, though I told him it was not. I should, however, have found it difficult to compel him to put in a pile foundation, and contented myself with warning him of the danger he ran of settlement. He had not got much above the first floor before the new building was found to be falling away from the adjoining building, and by the time he got the roof on, the gable overhung 18 inches. I served a notice on him compelling him to take it down, and put in a pile foundation, which he did, using piles 12 inches square and 16 feet deep, and the building has never stirred an inch since. The moral of this lies in the fact that had I gone to court in the first instance to compel him to use piles, I should probably have lost the case, for he could have pointed to a building not fifty yards away where sand piles had been used with perfect success, and could no doubt have got any amount of expert evidence in support of his contention. But here again the thickness and lengths of the piles required calls for judgment and experience if they are to be efficient and economical, for there is no sense in using piles strong enough to carry a twenty-storey building when one is erecting a two-storey villa. Section 82 is very useful, but likely to get the speculative builder up in arms. To be compelled to go down four feet for his foundations, where he has perhaps been accustomed to go only four inches, will lead to trouble; and in many cases there is no doubt it is a quite unnecessary depth, and by getting into the water likely to lead to less satisfactory and much more expensive work. With regard to steel and reinforced concrete buildings, these are used in so many different forms, and are even yet so largely of an experimental character, that it is necessary to walk warily in framing bye-laws to deal with these. I have read this portion of the paper with great interest, and I think the strength and use of the materials agrees very closely with our English practice, the regulations appear to be practical and simple enough to be

grasped even by an art architect or the average builder. The fact that so many buildings of this class are going up in this country shows that, however backward we may be in adopting bye-laws to deal with these buildings, we have still that saving grace of common sense which is above all bye-laws, and which is supposed to be the foundation of all law.

COMMUNICATED REPLY.

Mr. E. R. MATTHEWS: In reply to Mr. A. J. Price, the Author pointed out that the tables given by him in his paper, and which set out in detail the Regulations which are in force in a number of American Cities respecting the "Bearing Power of Soils," and "the Maxim Load allowable on Concrete and Brickwork Foundations," were not intended to be held up as models, the Author agreeing that these regulations vary too considerably, his object, however, in inserting these tables was more with a view of showing that regulations do exist in American Cities dealing with these very important points. He does not agree with Mr. Price that the Manchester Clause is "better and more useful," but maintains, as he has stated in his paper, that such a clause is altogether too indefinite and is practically useless. What, for example, asks the Author, is the definition of "Solid ground," or "A sufficient thickness of good concrete," or "Some solid and sufficient sub-structure"? The Author maintains that such terms as these are so indefinite that it would take a wiser than Solomon to give any satisfactory definition of what they mean. The Author is pleased to note that Mr. Price agrees that the London County Council Bye-law, which goes a little further than the Manchester Regulation, and which specifies that the depth of concrete foundations shall be nine inches, is an impracticable regulation, to expect that the foundations of a sky-scraper are to be of no greater thickness than those of a two-story building is of course absurd. With regard to the tables relating to Piled Foundations, the Author in this case also does not set these up as models, the piles used in America, and the methods of driving same, vary very considerably from those of this country, but his object is to show (1) that the American Regulations make it compulsory where a bad foundation is met with that piles shall be driven; (2) that they specify the size and form of the piles; (3) and that they

also state the maximum load allowable on each pile; and the Author maintains that in the building regulations of our cities and boroughs clauses should be inserted dealing with each of these three points, he does not suggest that the piles should be either of the size or form adopted in America; he agrees with Mr. Price that a certain amount of latitude should be given to the Surveyor so that he may have power to decide as to the length of piles that should be put in in each particular case.

THE CALCULATION OF STORM-WATER DISCHARGE, AND THE DESIGN OF SEWERAGE DETAILS.

By E. E. WALLINGTON BUTT, Graduate.

The first portion of this Paper deals with a subject of great importance to municipal engineers, and one on which there is a conspicuous dearth of information. It may be taken as a truism that the greatest efficiency in design can only be obtained when all the details of the problem are correctly appraised and adequately provided for. The Author, therefore, believes that an examination of the subject will not be without interest and value.

It must be clearly understood that with so many variable factors as the problem of storm-water drainage presents, exact mathematical accuracy is impossible. This statement is inserted lest the impression should be given that a simple formula for determining the sizes of sewers might be framed and used without discrimination for all types and classes of area.

The assumptions made by engineers with respect to rates of rainfall, and the corresponding discharge in sewers, are remarkably diverse. Although the importance of its accurate estimation is not generally recognised, many engineers, particularly in the United States of America, have investigated the problem and framed formulæ for computing storm-water discharge.

Among the best known of these formulæ is that of Burkli-Ziegler, a Swiss engineer, whose equation is as follows:—

$$Q = RC\sqrt[4]{\frac{S}{A}}$$

where Q = cubic feet per second per acre reaching sewers.
R „ average intensity of rain during the period of heaviest fall, in cubic feet per acre,
C „ a coefficient of impermeability varying from 0·31 for rural districts to 0·75 for well-developed areas; average value 0·625,
S „ general slope of area per thousand,
A „ drainage area in acres.

This formula was modified by McMath, of St. Louis, U.S.A., who proposed—

$$Q = RC\sqrt[5]{\frac{S}{A}}$$

where Q = cubic feet per second, per acre reaching sewers,
C „ a coefficient of impermeability,
R „ greatest intensity of rainfall in cubic feet per acre,
S „ mean slope of surface per thousand.

Other well-known formulæ are those of Messrs. Hawksley and Bazalgette in this country, and Colonel Adams in U.S.A., both of which include a factor for "general slope."

A great advance in this subject was made by Mr. Emil Kuichling, the City Engineer of Rochester, N.Y., who was the first to recognise that "the percentage of rainfall discharge from any given area increases uniformly with the duration of the storm, until a period is reached which is equal to the time required for the concentration of the drainage waters from the entire tributary area."

From his investigations and experiments, Mr. Kuichling arrived at certain conclusions, and framed the following formula:—

$$Q = Aat(b - ct)$$

where Q denotes discharge in cubic feet per second,
A „ drainage area in acres,
a, b, c „ empirical constants, which will vary for different localities,
t „ time required for the concentration of the storm water at the outlet.

It must be mentioned, however, that Mr. Kuichling worked

without the aid of a recording rain-gauge, which is a *sine quâ non* for experiments in this subject; and the general construction of the formula, with its three empirical constants, has operated against its use.

The formulæ of Burkli-Ziegler and others are faulty for the following reasons:—

(1) The sewer discharge is assumed to be constant over all shapes and classes of area.

(2) The general slope of ground is of little value for computations of this kind, as, even under the most favourable conditions, it can only be a rough approximation. What little value it has lies in the fact that the gradients of the sewers are largely dependent upon the general fall of the area.

One of the most important contributions on the subject of storm-water discharge was that of Mr. D. E. Lloyd-Davies,* which was read before the Institution of Civil Engineers recently.

The conclusions, which are summarised below, were mainly deduced from observations and experiments carried out in Birmingham, Plymouth, and West Bromwich.

(1) That the storm-water discharge from any defined district is directly proportional to the percentage of impermeable area comprised in it.

(2) That the discharge of storm water through underground channels is proportional to the aggregate rainfall during the time occupied by the water in travelling from the extreme boundary of the district to the point of observation, which time is called the time of concentration.

(3) That the maximum rate of flow occurs when—during a period equal to the time of concentration—the average intensity of rainfall is greatest.

(4) That the total volume of storm water is proportional to the maximum rate of flow.

From these conclusions, Mr. Lloyd-Davies framed the following formula, the great value of which lies in the fact that all the factors comprising the equation are adaptable to the characteristics of any district:—

Lloyd-Davies—

$$Q = \left(60{\cdot}5 \times \frac{60}{t} \times r\right) \times Ap$$

* *Proceedings of the Institution of Civil Engineers*, vol. clxiv., 1905-1906.

where Q = discharge in cubic feet per minute,
t = time of concentration (*i.e.* time of flow through longest line of sewers in district plus entrance allowance) in minutes,
r = rainfall in inches during t,
Ap = per centage of impermeable area in acres.

A full and complete understanding of the conclusions is essential if the formula and its application are to be appreciated. The Author, therefore, makes no apology for enlarging upon Mr. Lloyd-Davies' remarks.

Conclusion No. 1 is indisputable. A little thought will, however, show that a relationship exists between the percentage of impermeability and the density of population. Fig. 1 has been prepared to show this relationship. A chart of this description can at best be only an approximation, but, in the Author's opinion, the curve as plotted is sufficiently accurate for practical purposes. In cases where a very severe storm follows a long period of drought or a rainfall of long duration, when the permeable ground is either baked or saturated, the percentage of impermeability may not be shown correctly. But these cases are of extremely rare occurrence, and the risk of damage may reasonably be taken. A certain amount of risk must always be taken in designing storm-water sewers. To be absolutely safe with so variable a quantity as rainfall, an enormous outlay would have to be incurred, the resulting benefits being by no means proportionate.

With regard to conclusion No. 2, it is obvious that the greatest sewer flow cannot be reached until the product of Ap and r is at its maximum.

Broadly speaking, it means that all parts of the area must be contributing to the flow before the maximum is attained. Now, the entire area cannot contribute until the rain which fell at the extreme boundary of the district has flowed through the sewers and concentrated with the rain which fell on the nearer portions. Therefore, contributions from all parts of the area are not obtained at the same moment unless the duration of the storm equals or exceeds the time of concentration.

Conclusion No. 3. It is universally admitted that the intensity of rainfall varies inversely as the duration of the storm. This can be seen from the Rainfall Intensity Curve

(Fig. 2), which has been plotted from records of storms in Birmingham, but for practical purposes is applicable to all parts of this country. The curve is designed to cover all moderate amounts of rainfall, but does not include the very heavy falls of short duration, as these cannot be considered in economical design. As a matter of fact, the curve is exceeded five times in four years, and the risk of damage should be taken for the reason before given.

Seeing that the whole area cannot discharge unless the storm equals the time of concentration, and that the shorter the duration of the storm the greater is the intensity of the rain, it follows that the maximum sewer flow is likely to be reached when the duration of the storm exactly coincides with the time of concentration. While this is true in most cases, there are occasions when an exceptionally heavy downpour occurs in the middle of a storm. It is, therefore, the highest average intensity (over a period equal to the time of concentration) of this storm which furnishes the maximum sewer flow.

Conclusion No. 4 needs but little comment. It is interesting as a conclusion, but has little bearing on the application of the formula, which will now be considered.

In designing a system of storm-water sewers, the district should be divided into several portions according to the geographical conditions, and the various areas computed in the usual way. By counting the number of houses in each area, the population per acre can be ascertained, and by reference to the impermeable area percentage curve (Fig. 1), the percentage of equivalent impermeable area, Ap, can be estimated.

The preliminary lines and gradients having been laid out, the approximate diameters of the sewers are assumed. From the diameters and gradients the various velocities can be determined.

With these known, the time required for the rain falling on the most distant part of the area to reach the outlet can readily be calculated.

To this time must be added an allowance for the rain to enter the sewers. Where roofs are connected directly to the sewers, the minimum time is about one minute; but where the flow has to pass down the street gutters, the allowance should be increased to about three minutes.

The actual time of concentration being now known, the rate of rainfall, r, for that particular time is measured from the rainfall intensity curve (Fig. 2), and the factors of the equation are complete.

Mr. Lloyd-Davies, in his Paper, showed a graphic method of applying the time of concentration to a district, and Fig. 3 is a modification of his diagram. The heavy horizontal line represents t for the main stream, the lines at right angles give t for the tributary districts, the figure in the circle at the end of each line denoting the equivalent impermeable area of that tributary area in acres. It must be clearly understood that the lengths and positions of these lines are measured in units of time, and no other factor has any bearing.

To find the discharge at any point of the main stream, the sum of the areas to the right of that point gives the area discharging, the length of the line gives t; and with t known, r can be ascertained from Fig. 2.

$$\text{Then } Q = \left(60{\cdot}5 \times \frac{60}{t} \times r\right) \times Ap$$

Irregular districts sometimes give the maximum discharge when a certain portion of the district is omitted. A little judgment and a few trials with different areas and times of concentration will reveal the highest possible discharge.

In concluding this subject, the Author desires to mention a point of importance in the design of storm-water sewers, as it provides ample scope for the ingenuity and experience of the designer. It has been shown that r varies inversely as t, so that if t is increased, the value of r is automatically decreased, and therefore the maximum rate of flow from the whole area is diminished. By a careful arrangement of gradients and diameters, t may be artificially lengthened at trifling expense, with the result that sewers of smaller diameter will be required in the middle and lower reaches of the area. Of course, the total volume of rainfall discharge is not affected in the slightest degree by this jugglery. It is the maximum rate of flow that sewers are designed for, and it is in this maximum rate that reduction is made.

In comparison with the accurate determination of storm-water discharge, the calculation of dry-weather flow is a matter of little difficulty, and has therefore been omitted from this Paper.

It is unfortunate that so little attention has been paid to the efficiency of the various details of sewerage works. Of what use is a large overflow sewer if an inadequate length of weir at the summit, and a heavy flap valve at the outlet, reduce its efficiency? Has the ingenuity of sewerage engineers been exhausted in the design of stoneware pipe joints?

The Author suggests that the improvement of sewerage details provides an ample field for inventive faculty, and trusts that his remarks will stimulate interest in the matter, and thus lead to enhanced efficiency.

Storm Overflows.

The usual type of storm overflow, consisting of a free sewer with a sill placed at the level reached by six times the average dry-weather flow (sometimes with the upper portion of the outlet sewer masked), does not by any means fulfil requirements. When it is considered that in a combined system the storm flow is sometimes as much as 150 times the dry-weather flow, the need for greater attention in design will be appreciated.

Fig. 4 illustrates a type of overflow which with certain modifications is frequently adopted in Birmingham. Horizontally across the sewer, at the height attained by six times the average dry-weather flow, an iron plate, A, is fixed, to which is bolted a vertical deflecting plate, B, at an angle of about 30° with the foul sewer. When the flow exceeds the predetermined amount, the excess passes above the cut-plate A, and is deflected by B into the overflow sewer C, while the remainder passes under the plate to the continuation of the foul sewer.

In the early examples of these overflow chambers, considerable annoyance was caused by rubbish accumulating at the edge of plate A, but this has now been obviated by using the deflecting screen shown. The screen is formed of No. 15 gauge wires at ½" centres, and is quite successful in deflecting the rags, paper, and general rubbish down the foul-water sewer

while it offers no serious impediment to the course of the storm water to the overflow sewer.

It has been claimed for this type of storm overflow that the decreased hydraulic radius under the plate counterbalances the extra velocity of approach of the storm volume; that there is no impact, and consequently no static head generated; and that separation of the excess of 6 D.W.F. is accurate.

While not altogether supporting these claims, the Author recognises this design as a distinct improvement on the usual type.

When the cross-sectional area of 6 D.W.F. is small, the separating plate overflow just described is impracticable.

In these cases the leap weir type (Fig. 5), which is well adapted to sewers of steep gradients, is used, as the high velocity permits a long gap being left in the invert.

A desirable feature of this form of overflow is that the storm water passes on in a direct line, the foul flow, a comparatively small volume, being deflected.

Systematic inspection is necessary with this type also, if the arrangement is to be maintained in good working order, as rubbish sometimes collects on the cut-plate, and if not removed will allow contamination of the water-course.

Accurate separation is not always obtainable by this type, as, in the first place, it is not always possible to proportion the gap in accordance with the calculations, a narrow gap with its liability to choke being obviously impracticable if pollution is to be avoided.

The problem of separation when the velocity is high and the D.W.F. small is extremely difficult.

In each of the foregoing types of overflow chambers the theoretical degree of dilution is arbitrarily fixed by the Local Government Board requirements at six times the average dry-weather flow. As is well known, the rate of dry-weather flow varies from its minimum of 2·2 per cent. at 4 a.m. to its maximum of 6·2 per cent. at noon. This means that with a storm occurring at 4 a.m. the sewage is diluted with eleven times its volume, whereas, with a storm at midday, the dilution is only four times, assuming accurate separation in both cases.

In common with many other engineers who have encountered the problem, the Author has been impressed with the

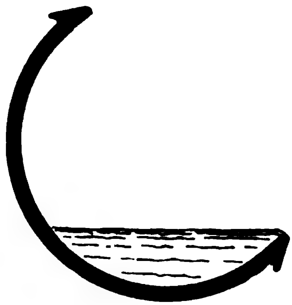
desirability of keeping the degree of dilution constant at all times, and Fig. 6 illustrates his suggested apparatus for doing so.

A is a tapering trough connecting the combined sewer with the foul sewer B. The trough is supported at its ends on roller bearings (not shown), and is capable of being tilted, by suitable mechanism, through an angle not exceeding 90°.

The cross-sectional area of the trough at its smallest part is proportioned to pass a predetermined quantity (flowing at a velocity which can be ascertained).

The essence of this device is the ability to vary the cross-sectional area (and therefore the quantity passed) according to the time of day. This is done by tilting the trough through

6 D.W.F. at noon.



6 D.W.F. at 4 a.m.

the required angle. Thus, at noon, when the dry-weather flow is high, the movement of the trough is so timed as to bring the weirs in a level position, consequently the cross-sectional area at this time is greatest. By 4 a.m. the trough has been tilted to the angle shown, so reducing the effective cross-sectional area to the required amount.

It will be noticed that in dry weather, with a certain flow coming down the big sewer, the hydraulic radius and velocity are gradually increased as the water passes along the trough, whereas, in times of storm, the hydraulic radius is decreased, and, in all cases, is brought to a constant value at the point C.

With the hydraulic radius and cross-sectional area constant (for the particular time of day), it follows that the quantity passed down the foul-water sewer is also constant, in which case the excess must overflow the weir and pass into the overflow sewer D.

For tilting the trough, the method illustrated (see Fig. 6, Plate I.) is suggested as being reliable and capable of use in the

majority of cases where an overflow of this description is likely to be placed. E is a tank which is filled with water drawn from the supply cistern F. Adjustable valves are provided to regulate the operations of filling and emptying to exactly the same period. These valves could be set at the works, and not require further attention.

The large and heavy float G is counterbalanced by the weights H and H_1. In its extreme positions a pointer simultaneously closes or opens the inlet and outlet valves. Though the rise of the float is uniform, the fall is dependent upon the square root of the head of water on the outlet valve, but this peculiarity could be adjusted in the design of the cam.

The rise and fall of the float gives motion to two sets of pulley wheels, JJ_1 and KK_1. To the inner pulley of each set is fixed a pawl L, which engage with ratchet clutches similar to M. These two pulleys rotate in opposite directions, and as one pawl takes up its work while the other runs free the upward and downward movement of the float is transformed into a slow rotary motion (once in 24 hours) of the cam N. The cross-sectional area of waterway in the trough having been calculated for various times of day, the cam is worked out to tilt the trough through the angle necessary to provide that area. An adjustable balance-weight is fixed to the trough, in order to reduce the work of the cam to a minimum. Delicate mechanism is quite out of place in a sewer, but the arrangement described has so few moving parts to get out of order that manufacturers to whom the Author submitted the design are prepared to guarantee its satisfactory working.

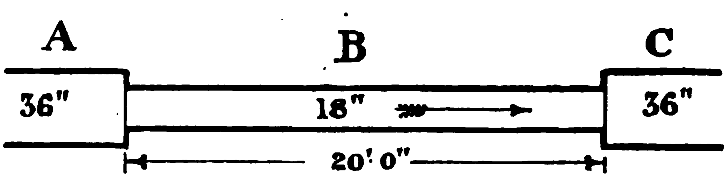
Bellmouths and Adjutages.

The important bearing which entrance and outlet resistances have upon the design of sewerage works is not fully appreciated. In point of fact, except in the most abstruse text-books, it has never been drawn attention to, and the author is therefore greatly indebted to Professor Alexander, of Queen's College, Cork, for the following communication :—

"It requires little consideration, when watching the flow of water, to see the advantage of making the entrance as free from corners and abrupt changes of section as possible. Where water is allowed to dash against vertical faces, its passage is

impeded, and in storms the larger volume is only discharged after heading up sufficiently to overcome this, as it is called, 'entrance resistance.' Now, the object of this note is to emphasise the great importance of eliminating this form of obstruction, by showing its actual magnitude, and to further point out the equal, and oftentimes greater, necessity for providing an appendage or adjutage, to allow the water to resume its normal flow.

"Consider first a water main, diameter 36″, with a length of 20′ 0″ of pipe of diameter 18″, with abrupt changes of section.



"Let the velocity in A and C be 4′ 0″ per second,

Then the velocity in B is 16′ 0″ per second.

"To pass the water from A to C, energy or head of water must be expended as follows:—

"(1) Overcoming the entrance resistance, the amount of this is

$$h_e = n\frac{V_B^2}{2g} = \left(\frac{1}{C} - 1\right)^2 \cdot \frac{V_B^2}{2g}$$

C = coefficient of contraction = 0·64 here,

n = 0·32, and

$$h_e = 0{\cdot}32\frac{V_B^2}{2g}$$

"(2) Producing the increase in velocity, this is

$$h_{v_e} = \frac{V_B^2 - V_A^2}{2g}$$

"(3) Overcoming frictional resistance in 20′ 0″ length. Take an equation—

$$V = 154\sqrt[3]{R^2}\ \sqrt{S}$$

to represent the law of resistance.

$$h_f = \frac{LV_B^2}{23700\sqrt[3]{R^4}} \text{ approx.}$$

"(4) At the outlet end, the head spent in developing the increase in velocity ought to reappear as a static pressure, so that

$$h_{v_o} = \frac{V_B^2 - V_C^2}{2g}$$

should be recovered again. But

"(5) In passing abruptly from the small to the large section a loss is sustained, that being

$$h_s = \frac{(V_B - V_C)^2}{2g}$$

"The complete equation, then, is

$$H = h_e + h_{v_e} + h_f - h_{v_o} + h_s$$

$$= 0{\cdot}32\frac{V_B^2}{2g} + \frac{V_B^2 - V_A^2}{2g} + \frac{LV_B^2}{23700\sqrt[3]{R^4}} - \frac{V_B^2 - V_C^2}{2g} + \frac{(V_B - V_C)^2}{2g}$$

Since $V_A = V_C$, this becomes

$$H = 0{\cdot}32\frac{(16)^2}{64} + \frac{20(16)^2}{23700\sqrt[3]{(\frac{3}{8})^4}} + \frac{(16-4)^2}{64}$$
$$= 1{\cdot}28' + 0{\cdot}80' + 2{\cdot}25' = 4{\cdot}33'$$

Thus, the entrance loss is 1·60 of the frictional loss
and the outlet „ 2·81 „ „

"This shows clearly that the heading up is due much more to these avoidable causes than to the extra frictional resistance.

"It is possible, then, to have a head of 4·33′ caused by a short culvert, where only 8′ is due to the increased friction, but it is also possible to eliminate all the head except this 8′, and thus avoid the great trouble and expense of reconstruction of the culvert, even if that be feasible.

"The entrance loss is minimised by prefixing a trumpet-shaped or bell-mouthed orifice, to lead the water gently in along gradually converging lines.

"The outlet loss is abolished by a corresponding appendage, gradually enlarging from the restricted pipe or culvert to the full section or open channel. These two contrivances are seen in the well-known Venturi meter.

"Regarding the actual dimensions, the writer has only made sufficient experiments to say that he believes the absolute shape is not so material as is the securing of a gradual evenly converging inlet and a rather longer diverging outlet, as on the Venturi meter.

"Experiments on a model proved that the mathematical relations given above are correct, and the working of bell-mouths constructed on a large scale justifies every anticipation in the most ample and satisfactory manner."

In the case of sewers which are designed to run full or under a slight head, a convenient way to reduce entrance loss is to form a hood or bonnet at the outlet of the manhole. This may be done by tipping the last drum at an angle of about 5° to 10°. See Fig. 8.

A calculation in respect of 380 yards of 2′ 6″ and 3′ 0″ brick barrel sewer at Liverpool Street, Birmingham, showed that with hoods on the outlets of the four manholes the efficiency of the sewer was increased by over 9 per cent.

The ability to recover the head expended in producing an increase of velocity is extremely valuable, and particularly so in such details as river crossings. To emphasise the importance, a similar example to that taken by Professor Alexander (but with the losses reduced to a minimum) has been worked out. Fig. 7 shows the methods adopted to eliminate entrance and outlet losses. The dotted line denotes the hydraulic gradients, which indicate 11½″ as the total loss of head.

It must be understood that the necessary head for producing the increased velocity must be generated and expended before it can be returned. This entails an increase in the hydraulic gradient of the lower reach at the expense of the hydraulic gradient of the upper length.

Another instance of the usefulness of this arrangement is shown in Fig. 8. The sketch illustrates a syphon presenting somewhat unusual features, which has been designed for a 30″ storm-water sewer in Birmingham.

In all large towns great difficulty is frequently experienced in finding a suitable line for new sewers, and the figure illustrates a case in point.

If the principle now being discussed were not available, it would have been necessary to syphon the 30″ storm-water sewer

under the 3′ 6″ × 2′ 6″ foul-water sewer with a considerable increase in cost and decrease of efficiency.

Advantage is taken of the favourable levels to drain the water retained by the syphon into the foul-water sewer. This obviates any chance of the restricted portion being further reduced by the silting which takes place in all inverted syphons with an intermittent flow.

Another point of considerable interest in connection with this design is the curvature of the bends, which may appear to some to be extremely sharp.

From experiments carried out at the Birmingham University, Professor Alexander * definitely established that the loss per unit length of curve increases with the curvature, but that the decrease in the total length of curve brings the actual loss to a minimum when the radius of the bend is five times the radius of the pipe. The extra resistance offered by a bend is given by the equation

$$L = 12{\cdot}85 \sqrt[6]{\left(\frac{r}{R}\right)^5}\, l$$

where L = the length of straight pipe offering the same resistance to flow as the extra resistance due to bends,

r = radius of pipe $= \frac{D}{2}$,

R = radius of bend,

l = length of curve along centre line.

Fig. 9 is a graphic representation of this equation, which is not applicable to bends of sharper curvature than $2\frac{1}{2}$ diameters.

To the length of L so found is added the actual length of the bend l, the sum being equivalent for the purposes of discharge to the actual pipe with its bends.

The first application of this equation was in the Hope Street Syphon, Birmingham, which is illustrated in Fig. 10, and the following particulars are given to show the important bearing which bends even of the highest efficiency have upon the design:—

Diameter = 3′ 0″,
Total length of C.I. pipe = 82′ 6″,
Number of bends = 6,

* *Proceedings of the Institution of Civil Engineers*, vol. clix., 1904–1905.

Curvature of each bend = 0·2 = five times the radius of pipe,
Angle of deviation of each bend = 40°,
Length of each bend on centre line = 5′ 3″,
Total length of bends = 31′ 6″,
$L = 12{\cdot}85(0{\cdot}2)^{0{\cdot}83} \times 31{\cdot}5 = 3{\cdot}378 \times 31{\cdot}5 = 106{\cdot}4'$.

This syphon, with a total length of 82·5′ (including bends), therefore, offers the same resistance to flow as a straight pipe whose length is 82·5 + 106·4 = 188·9 feet. It will be noticed that the loss of head due entirely to the curvature of the bends is 56 per cent. of the total loss.

In the design of this inverted syphon the full benefit of the velocity of approach has been retained, entrance loss has been eliminated, and ample provision made for cleaning when necessary.

Automatic Regulating Apparatus.

The applications of a device for automatically regulating the quantity of sewage passing down a sewer are numerous. In joint schemes of sewerage they are particularly useful for controlling the amounts of sewage contributed by the respective districts, and at outfall works they are of great service in regulating the flow to the filter beds.

In Fig. 11 is shown diagrammatically the Author's device. The broad principle is that of an adjustable orifice which automatically enlarges or decreases according to the amount of head.

The door is operated by means of a cam, which is oscillated by the rise and fall of a large counterbalanced float working in a chamber directly connected to the sewer. The slightest alteration in the depth of flow causes a corresponding alteration in the position of the float. The movement of the float is transmitted to the cam, which is carefully calculated to adjust the size of the orifice in relation to the static head.

Some care is required in designing the outlet of the sewer into the gauging chamber.

When the flow is greater than the regulated quantity the excess is pounded and its velocity lost. The velocity of the incoming flow must therefore be gradually diminished by a special adjutage, otherwise impact would render the device inaccurate.

The quantity to be gauged may be altered within certain limits, and the apparatus is easily calibrated and adjusted.

It will be noticed that all the mechanism of this device is exceedingly simple, and there is little likelihood of derangement. Corrosion has been guarded against by the use of non-corrosive metal, and the manufacturers give a guarantee of its efficiency.

Flap Valves.

The low efficiency of flap valves as details of sewerage systems is somewhat remarkable.

During recent years a great improvement has been made by reducing the weight of the doors, and in this connection the introduction of a domed flap is noteworthy.

The fact remains, however, that the usual type of flap valve often requires more head to fully open it than is available, with the result that back-pounding and flooding are of frequent occurrence.

Fig. 12 illustrates a flap valve of considerable merit, which was invented by the late Mr. F. G. M. Stoney of sluice fame.

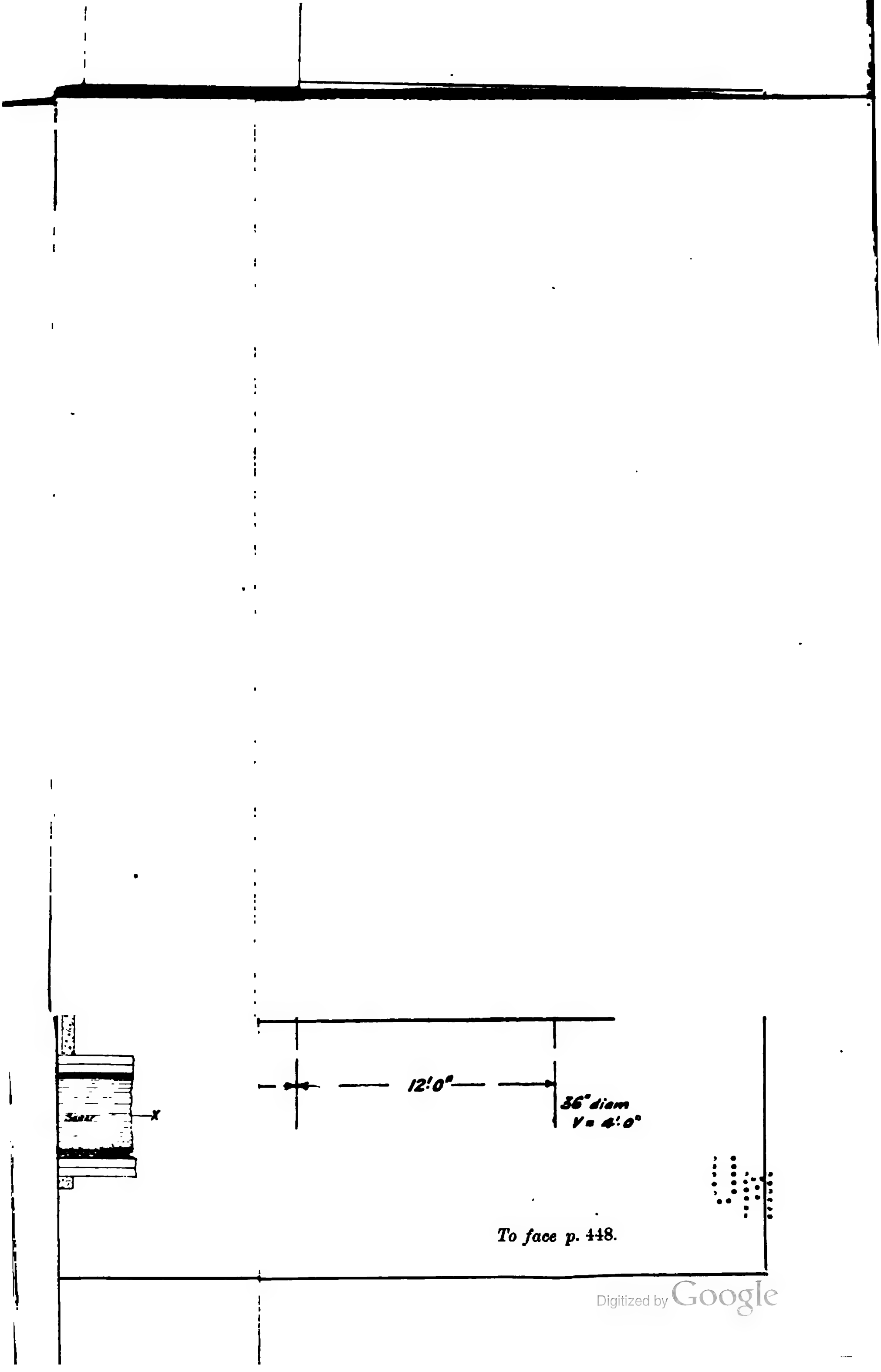
The door is counterbalanced, and opens with uniform ease to its full capacity. The valve is not hinged to the frame in any way, but is supported by means of two rollers which roll backwards and forwards as the door opens and closes.

The function of the toothed rack is to ensure the rollers acting equally. Friction has been largely eliminated, and the valve appears to be particularly efficient and reasonably free from any liability to derangement.

Rubber as a material for flap valves was suggested to the Author by Mr. J. T. Eayrs, M.Inst.C.E. The Author was much impressed with its value, and devised the valve shown in Fig. 13.

The frame is a plain and simple casting, and does not call for comment.

The door is made of rubber in which are embedded horizontal wires which extend right across the door and abut upon the edges of the frame. These wires are drawn from phosphor bronze as a safeguard against corrosion, and enable the door to resist outside pressure. There are no hinges on this valve. The door bends freely outwards, and the corrugations on the rubber facilitate this bending. These valves are absolutely water-tight. In the event of rags clinging round the lip of the



To face p. 448.

frame, the rubber adjusts itself to the obstruction until the latter is removed.

The specific gravity of this combination of rubber and bronze is only slightly greater than that of water, which is one of its most valuable features.

Valves of this type are not claimed to be imperishable, but their first cost is not high, and an allowance can always be obtained for old rubber.

The examples which have been chosen do not by any means exhaust the list of auxiliary works which are capable of improvement, but sufficient has perhaps been written to show the desirability of greater attention being paid to the efficiency of details.

Sewerage is already one of the most important branches of municipal engineering, but in the near future, with the development of urban areas, the treatment of the problem on more scientific lines will be necessary. The Author, therefore, trusts that his explanation of Mr. Lloyd-Davies' treatise will be appreciated.

Acknowledgments are due to Professor Alexander for his valuable contribution; to Mr. Leslie Roseveare and Mr. C. F. R. N. Weston, Assoc.MM.Inst.C.E., for their advice and assistance; and to the City Engineer of Birmingham, Mr. H. E. Stilgoe, M.Inst.C.E., for permission to furnish particulars of the Hope Street Syphon (Fig. 10).

COMMUNICATED DISCUSSION.

Mr. T. W. A. HAYWARD:—I regard Mr. Lloyd-Davies' equation as the greatest advance yet made in the calculation of storm-water discharge, and I am glad that Mr. Butt, with his knowledge of the subject, has explained the pertinent parts of Mr. Lloyd-Davies' paper for the benefit of this Association.

The scheme for artificially lengthening the time of concentration is exceedingly ingenious, but difference in cost of sewers of large size is small in comparison to their discharging capacities, and I doubt whether the saving in size in the lower reaches would pay for the extra excavation necessary to make the top lengths of sewers flatter in gradient. Still, the idea is original, and without going fully into the matter I am unable to say

more. In this connection there is an apparent discrepancy with one of Mr. Lloyd-Davies' conclusions. Mr. Butt states that the total volume of storm water is not altered, but that the maximum flow is reduced. This is at variance with the fourth conclusion of Mr. Lloyd-Davies, and I should like the matter explained.

Mr. Butt is in error in stating that the overflow chamber (Fig. 4) was introduced at Blackburn. The type was invented by Mr. J. E. Wilkes, A.M.Inst.C.E., of the City Engineer's Office, Birmingham, and though the design has been modified, the idea remains the same. My objections to this form of overflow are as follows:—

1. It places an obstruction in the sewer.
2. The hydraulic radius is *suddenly* decreased.
3. The variation in the velocity of approach is not compensated.
4. The flimsiness of No. 15 gauge wires.

Objection No. 2 would be overcome if the edge of the separating plate was placed obliquely to the flow instead of at right angles to it.

The leap-weir type of overflow in my opinion is no better than the ordinary type, and I cannot understand why Mr. Butt included it in his paper. It possesses a variety of inherent defects, and only one good point, namely, that the storm water passes on in a direct line.

With this exception the overflow chamber invented by the Author fulfils every requirement of an overflow chamber that is known to me, if, and I emphasise these reservations—

1. The joints between the sewers and the trough can be made watertight without undue friction.
2. If the water clock can be regulated to a sufficient degree of accuracy; and,
3. If the velocity of the storm flow can be gradually checked in a practicable length of trough.

I am prejudiced against even the most simple mechanism being placed in a sewer, but if it is desired to keep the degree of dilution constant, I can see no alternative. I must admit that the arrangements for tilting the trough are as simple as are likely to be obtained, but I should only resort to this type of overflow where every drop of foul water had to be pumped. In such cases it would be very useful, and would amply justify

its extra cost. A point not mentioned by the Author is that an overflow giving six times the average dry-weather flow might be constructed with a *fixed* trough, and this would make a very efficient type, which could be used on small-pipe sewers where other types are impracticable.

I have been greatly impressed by the communication from Professor Alexander, and regard it as one of the most important that has come before this Association.

It is somewhat singular that Mr. Shone, in his paper, remarks upon the evil effects of sudden variations of velocity, entrance and outlet resistances, and resistances due to bends, and that Mr. Butt's paper should show the magnitude of these losses and explain how they might be avoided. The only dissimilar point is that Mr. Shone deals with air, and Mr. Butt with water.

I am somewhat surprised to find that, on a long length of sewer entrance, loss on four manholes should reduce the discharging capacity by nine per cent., and the slight cost of tipping four drums to an angle was certainly justified.

The inverted syphons, illustrated in Figs. 8 and 10, are the most advanced in design that I have seen, and reflect the greatest credit on the designers.

Assuming a velocity of 6 feet per second, the Hope Street syphon absorbs 4 inches of head—a fact which speaks volumes for its efficiency.

An automatic regulating device is exceedingly useful. I have, however, always been sceptical of the possibility of regulating the flow by means of an adjustable orifice. The idea of a cam, which could be calibrated and altered is very good.

The two flap valves illustrated look efficient, but I imagine that 18 inches diameter would be the minimum size of the iron valve, and also the maximum size for the rubber one. A good point in connection with the rubber valve is its extreme lightness, and also its ability to coil up at the bottom in order to accommodate itself to the various flows.

A. J. PRICE: With the conclusions of Mr. D. E. Lloyd-Davies I think there will be general agreement, and the formula he has framed has the merit of being simple and practical. At the same time, there are one or two points in Mr. Butt's extension of these conclusions on which a word may be said.

While it is no doubt true that there is a close relationship

between the percentage of impermeability and the density of population, it must not be overlooked that there are many places where the density of the population is hardly a safe guide as indicating the permeability, or, in other words, the extent of the paved area. For example, take the case of an area covered with residential flats or model dwellings, and another covered with single or two-storied cottages. The paved area (and roofs) may be the same in both cases, but the population of one may be four or five times that of the other, and the storm water which will reach the sewer only be the same in each case. Again with regard to permeability, I think it should be recognised that different soils are affected differently by drought or rainfall. During a long drought clay ground may become so baked that the surface is almost equal to a paved area, while drought on a sandy soil will greatly increase its permeability.

It might be made a little more clear, though the conclusion of the Author covers it, that the period of concentration will refer to the time at which the rainfall reaches the various storm overflows (if any), and not necessarily the outfall.

I am afraid that I can hardly agree with the Author that we cannot consider heavy falls of short duration in economical design. Nearly all damage is done by thunderstorms which are not usually of great duration, and the trend of modern practice is to make much greater provision than formerly for dealing with storm water.

It is of the greatest importance that something like agreement should be arrived at as to the quantity of storm water to be provided for from the built-up area, and seeing that $2\frac{3}{4}$ ins. fell in an hour while I was at Worcester in 1895, and one inch of rainfall has been recorded in London as falling in ten minutes, I believe it will be found necessary in most places to deal with a rainfall of from one to one and a half inches per hour. As a rainfall of $\frac{1}{4}$ inch per 24 hours falling on a built-up area is roughly equal to the dry-weather flow from the same area, *i.e.* after allowing for percolation and evaporation, that only 50 per cent. reaches the sewers, it follows that provision for one inch per hour is in round figures 100 times the dry-weather flow. To provide for storms of these dimensions it is almost economically impossible without the use of storm overflows, and the illustrations given of these by Mr. Butt are most interesting.

The storm overflow given in Fig. 4 appears to be a very useful arrangement if made strong enough and properly attended to. It should to a great extent prevent the nuisance frequently experienced where storm-water overflows discharge into a shallow brook flowing through a thickly populated district. It appears to me, however, that the wires are so weak and so close together that it is very likely to get clogged up with the rags and paper always brought down by a heavy storm, and the volume of the flow will be greatly reduced and the screen itself probably broken down. Judging from the experience with a wider and much stronger screen at my own sewage works, I should say clogging or breakage is very likely to occur if it is not very frequently cleaned, and strengthened.

I certainly share Mr. Butt's fears of the overflow in Fig. 5 getting blocked, and should prefer a simple brick or concrete weir across the sewer fixed at such a height that sewage to the capacity of the foul sewer would in dry weather be diverted into the foul sewer. If this had a good bell-mouthed inlet, there should be no risk of stoppage, and a bull-nosed weir fixed at the level of the cut-water plate shown in the illustration is not nearly so likely to cause a stoppage as the plate.

I am afraid I am somewhat prejudiced against mechanical contrivances in sewers, as they are so liable to get out of working order, and, speaking generally, being out of sight are out of mind, and frequently badly neglected. So far as I can judge from the drawings and description, Mr. Butt's tilting trough, and his cam arrangement for operating the valve to the storm-water sewer are very ingenious and cleverly designed. The flap valves are novel, but the valve with the toothed rack appears costly, and the indiarubber valve, though likely to be watertight, will, I am afraid, not be very durable. The syphon for the Hope Street storm-water culvert is an interesting piece of work, and the experiments of Professor Alexander and Mr. Butt with regard to the resistances at the entrance and outlets of sewers emphasises the necessity of providing bell-mouthed openings and exits.

Mr. Leslie Roseveare: I am sure every member of this Association, and especially those who are not the recipients of the minutes of the Institution of Civil Engineers, will welcome Mr. Butt's comprehensive *résumé* of Mr. Lloyd-Davies' paper on a subject upon which, considering the

varying factors involved, there seems to be a dearth of actual data.

As suggested in the paper, the absolute necessity in the design of all sewerage schemes of thoroughly grasping the importance of, and allowing for the "time of concentration" of the system, cannot be too greatly emphasised, and the results will, in many cases, come as a surprise to those Engineers who are satisfied to take a certain fixed rainfall, and calculate for the whole or any section of the drainage area on that basis. I have a case in point in my mind at present where the calculation at the junction of a branch sewer with the main outfall sewer, estimated on the proposed lines, gave a rainfall allowance of $1\frac{1}{2}$ inch for the former, and only $\frac{3}{4}$ of an inch for the latter per acre discharging at that point.

Given a decision as to the maximum rainfall curve which economic considerations will allow, gained from a study of the diagrams of efficient self-recording rain gauges placed in various spots on the drainage area and plotted as in Fig. 2, and the time of concentration plotted in a somewhat similar manner to Fig. 3, but preferably as shown in Mr. Lloyd-Davies' paper, the only uncertain factor in this usually empirically treated calculation is the question of the impermeability of the area, the most satisfactory basis for which is that of the population per acre.

Fig. 1 may give a very rough approximation, but I think it will be agreed that this is especially a case in which every area is a law unto itself, having regard to the actual amount of impermeable area varying with the bye-laws as to width of roads, etc., and the proportion of permeable area which should be calculated as and added to the impermeable area, this again varying with the subsoil, slope of the ground, and the previous rainfall.

While results will necessarily vary, research work on the lines of this last factor, especially by Engineers, whose systems discharge into storage tanks making actual measurements practical, should make it possible to obtain something nearer than the present approximation in calculating the impermeability of an area on the population per acre basis, by gauging the actual discharge from the sewer during an accurately registered rainfall, taking the time of concentration into account. A few results obtained may be of interest.

Area in acres.	Population per acre.	Impermeability.	Notes.
19	147	100 per cent.	
312	125	83 "	
190*	75	38 "	To surface-water sewer.
		24 "	To foul.
232	17	18 "	Sand and gravel subsoil, average slope, 1 in 30.

Mr. Pickmere's statement of the proposed legislation to enforce the deposit of detailed plans of the whole of estates as they are proposed to be laid and to insist on some settled planning of outside districts, will be welcome news to those who have to calculate the sizes of main sewers, which will at some date receive the drainage of these undeveloped districts.

The wire screen shown on Fig. 4 is suitable, and has only been used for the upper part of a water-shed where the stream into which the overflow discharges is small, and the sewer itself not of a size in which heavy timbers, etc., are sometimes found. Copper or phosphor bronze wires will in future be used, as the corrosion on the steel wires previously tried tends to prevent small pieces of paper, etc., being washed down the screen, and so under the plate. With reference to the question of impact and static head in this chamber, the former can be practically eliminated by a short length of weir placed before the plate, and the presence or otherwise of the latter will depend upon the relative hydraulic radii of the approaching storm, and that of the stream cut off, and also on the length of the plate with its relatively decreased hydraulic radius. Given an average length plate, static head has been found to be non-existent.

Fig. 6 shows an ingenious contrivance, but unfortunately has all the defects in a magnified form of the old weir type of overflow. Apart from this, I think it will be found that Engineers, who have tried the water-clock apparatus with small valves for inflow and especially outflow gauging, agree unanimously as to its inaccuracy and general unsuitability. Six times the dry-weather flow where an apparatus of this description would be likely to be used is often not enough to

* Partially separate system; roads, roofs and front gardens going to S.W. sewer.

prevent nuisance with the overflow, and the six times dilution of the maximum dry-weather flow is found to be preferable.

Fig. 8, showing an adaptation of the formulæ common to the Venturi meter, while not usually suitable for sewerage works, care being taken not to make the area of the "neck" too small, it is occasionally useful in avoiding large obstructions as shown on the diagram, especially for a storm-water culvert which does not receive the overflow from a main sewer above, but simply takes contributions from street gullies and down-pipes.

Professor Alexander's contribution is especially interesting as emphasising not only the advantage of the bellmouth to overcome entrance loss whereby, as mentioned in the paper, at the cost of about £4, the efficiency of about 400 yards of main sewer was increased by over 9 per cent., but also the more rarely appreciated fact of the increased efficiency obtained by the use of an adjutage. As a matter of fact, it has been found that with certain velocities, and under some conditions, an adjutage will give a greater discharge to a culvert than a bellmouth.

REPLY TO DISCUSSION.

In reply to the remarks of Mr. Price regarding the estimation of paved area, the Author begs to point out that residential flats and model dwellings are usually erected in a highly developed district where the area is almost wholly impermeable. The excessive density of population in the flats would not in such cases affect the reading of the curve.

Mr. Price is quite correct in his remark regarding the porosity of different soils after a period of drought or rainfall. It is considerations such as these that give point to Mr. Roseveare's contention that "every area is a law unto itself." With Mr. Roseveare the Author agrees that density of population is the most satisfactory basis for calculating the impermeability, also that research work into the run-off from various areas would be exceedingly valuable.

Mr. Price questions the wisdom of not providing for the short and heavy downpours, and instances rainfalls of 2¾ inches in an hour at Worcester, and 1 inch in ten minutes in London. The curve (Fig. 2) includes storms of 1⅓ inch in ten minutes,

but rainfalls of 2¾ inches in an hour are so very rare that the cost of providing for such storms would not be permissible.

Mr. Hayward in his criticism points to an apparent discrepancy with Mr. Lloyd-Davies' fourth conclusion. There is, however, no discrepancy. In any system of sewers, no matter whether the time of concentration be long or short, the relationship between the total quantity received, and the maximum rate of flow in that system is preserved.

Mr. Hayward's objections to the separating plate type of overflow have some justification. His suggestion of placing the edge of cut plate obliquely to the flow has been anticipated, but this method introduces a difficulty in arranging the wire screen.

In spite of its flimsiness, the wire screen is of ample strength. Mr. Price appears to have misunderstood the function of this arrangement. It is to *deflect* the rags and general debris under the plate—hence the inclination and the close spacing of the wires.

With regard to the overflow chamber (Fig. 6) and Mr. Hayward's reservations, the Author suggests a V-shaped staunching ring to keep the joints between the sewers and the trough watertight.

In the opinion of the manufacturers (who probably have had more experience in this class of work than any one in Great Britain) there is comparatively little difficulty in making the rise and fall of the float keep reasonably accurate time. But the power required to tilt the trough is a varying quantity, and the float must be submerged to a greater or lesser degree to overcome the resistance. The Author believes that if the float is of large area the lag or advance of the float would not make a serious difference to the correct height of the weir. It might be possible to adjust this defect in the curves of the cam, and it might also be desirable to introduce some form of parallel motion to the rocking arm, but the Author thinks that these refinements are unnecessary.

Whether the excess of 6 dry-weather flow can be overflowed in a moderate length of trough is a question difficult to decide without trial. The possibility of making a fixed trough overflow has not been lost sight of. The Author believes that its taper form is a very desirable feature.

Mr. Hayward's high opinion of the Hope Street syphon is shared by the Author.

Mr. Hayward is not alone in his scepticism regarding the practicability of regulating sewer flow by means of an automatically adjustable orifice. There are so many varying conditions that the problem has rightly been regarded as an exceedingly difficult one. For instance, the head of water acting on the door, and the friction due to that pressure, is a varying quantity. To overcome the extra friction the float must lag until the lifting power of the float is increased sufficiently. Again, unless some form of parallel motion is introduced, the angularity of the rocking arm would affect the position of the door; but the Author is of opinion that a satisfactory and sufficiently accurate regulating apparatus is possible on the lines illustrated diagrammatically in Fig. 11.

The thanks of the Author are due to the gentlemen who have so ably criticised the paper. The numerous letters from known and unknown correspondents indicate that the paper has been of interest to a large number of Members, a fact which affords the Author much gratification.

The Members dined together on Thursday evening, June 20, *at the Exchange Station Hotel.*

On Friday, June 21, *they proceeded in cars and inspected Lister Drive Generating Station. At Croxteth Gates the members inspected pitch macadam pavement in course of construction, the Smithdown Road Destructor Depôt, Sefton Park, and proceeded by the Overhead Railway to Huskisson Dock, where a visit was paid to the s.s. "Saxonia."*

The Members were entertained to luncheon on Thursday and Friday by the Health Committee of the Liverpool Corporation.

On Saturday, June 22, *the Members proceeded by special train from Lime Street to Penmaenmawr, where they were received by Col. Darbyshire. The quarries were thoroughly explored, the members first inspecting the hoppers and pier, Penmarian Mill. At the next level the party viewed a blast of* 15 *holes* 23 *feet deep. They were entertained to luncheon, and afterwards visited Plasmawr, the residence of Col. Darbyshire.*

APPENDIX.

STATISTICAL RETURNS

On the following subjects lie at the Offices of the Association, 11 Victoria Street, Westminster, S.W. Those marked thus * are in duplicate, and can be borrowed for perusal by Members on application to the Secretary. Those *not* marked * can only be inspected at the Offices.

N.B.—PLEASE QUOTE REFERENCE NUMBER WHEN APPLYING FOR LOAN OF RETURNS.

(*Members are requested, when kindly sending statistics, to do so in duplicate if possible.*)

Ref. No.	
	ABATTOIRS (PUBLIC).
12	W. Chapple Eddowes. 1902.
	CEMETERIES (PUBLIC).
53	*H. Richardson. 1904.
	DRAINAGE CONNECTIONS (PRIVATE).
11	*H. Richardson. 1902.
	DRAINAGE (HOUSE).
1	J. Atkinson. 1894.
	DRAINAGE (NEW BUILDINGS).
49	*E. J. Lovegrove. 1896.
	FIRE BRIGADES.
36	G. T. Lynam. 1899.
	HOSPITAL (INFECTIOUS DISEASES).
59	*J. Walker Smith. 1905.
	LABOUR, CONDITIONS OF.
63	*A. E. Collins. 1906.
	LIGHTING (ELECTRIC).
3	J. W. Brown. 1894.
4	J. W. Cockrill. 1891.

Ref. No.

LIGHTING (ELECTRIC).

5 W. A. Davies. 1893.
40 E. J. Silcock. 1896.

LIGHTING (GAS).

6 J. W. Bradley. 1895.
7 P. Ross. 1896.

LIGHTING (PUBLIC STREET).

8 A. H. Campbell. 1895.
9 C. C. Smith. 1892.
48 *E. J. Lovegrove. 1900.
54 *A. E. Nichols. 1903.

LIQUID NIGHT SOIL (DISPOSAL OF).

38 *G. T. Lynam. 1899.

MOTOR WAGONS (UTILITY AND WORKING OF).

57 *J. Walker Smith. 1905.
58 *R. J. Angel. 1903.

PAVEMENTS (COMPARISON OF LIFE AND COST OF GRANITE AND GRITSTONE).

10 C. F. Wike. 1890.

PAVEMENTS (TAR MACADAM).

46 A. E. Collins. 1896.
47 J. Hall. 1896.
41 E. A. Stickland. 1897.

PRIVATE STREET IMPROVEMENTS (CONSTRUCTION OF WORKS OF).

13 W. J. Newton. 1892.
56 *T. J. Rushbrooke. 1905.

PUBLIC BATHS AND WASHHOUSES.

42 *P. Edinger. 1897.
55 *J. Walker Smith. 1905.
65 A. H. Campbell. 1907.

REFUSE (COLLECTION OF).

14 J. Price. 1891.
2 *A. E. Nichols. 1906.
60 *E. A. Borg. 1906.

Ref. No.	
	REFUSE (DESTRUCTORS).
15	W. Brooke. 1885.
33	J. Gammage. 1899.
	REFUSE (DISPOSAL OF).
16	J. Price. 1896.
	REFUSE (REMOVAL OF).
17	C. R. Fortune. 1886.
	ROADS (MAINTENANCE OF MAIN IN NON-COUNTY BOROUGHS).
18	W. Howard-Smith. 1894.
	ROADS (PAVING OF MAIN).
31	H. Richardson. 1899.
	ROADS (STEAM ROLLING OF).
19	A. W. Parry. 1885.
	ROADS (WATERING OF).
20	W. Dawson. 1891.
	SCAVENGING (STREET).
17	C. R. Fortune. 1886.
	SEWAGE (BACTERIAL TREATMENT OF).
66	J. S. Pickering. 1905.
	SEWAGE (DISPOSAL OF).
21	J. H. Cox. 1892.
22	H. Richardson. 1890.
39	J. W. Cockrill. 1900.
	SEWAGE DISPOSAL WORKS.
35	*G. T. Lynam. 1899.
	SEWAGE (PURIFICATION OF).
22	H. Richardson. 1890.
	SEWERS (VENTILATION OF).
23	J. T. Earnshaw. 1893.
51	*H. G. Whyatt. 1900.
	SEWER VENTILATION.
64	*J. Price. 1906.
	SLAUGHTER-HOUSES.
25	J. W. Cockrill. 1885.

Ref. No.	
	STREETS (CONSTRUCTION OF NEW).
50	*T. R. Smith. 1902.
	SUPERANNUATION.
62	*A. E. Collins. 1906.
	SWIMMING BATHS,
61	*P. R. A. Willoughby. 1906.
	TEAM LABOUR.
52	*T. J. Rushbrooke. 1904.
	TRAMWAYS.
26	J. E. Swindlehurst. 1891.
	TRAMWAYS (ELECTRIC).
24	*G. T. Lynam. 1903.
34	Town Clerk of Birmingham. 1899.
43	Chas. Mayne. 1897.
	UNDERGROUND TELEPHONE AND TELEGRAPH WIRES.
37	*G. T. Lynam. 1899.
	WATER RATES.
44	A. W. Lawson. 1898.
	WATER SUPPLY (DIAMETERS AND DEPTHS OF MAINS FROZEN IN 1895).
27	E. Pritchard. 1895.
	WATER SUPPLY (FOR DOMESTIC AND GENERAL PURPOSES).
28	J. T. Eayrs. 1890.
	WORKMEN'S DWELLINGS.
29	*J. W. Cockrill. 1897.
	WORKMEN'S WAGES AND HOURS OF LABOUR.
45	J. R. Dixon. 1897.
30	R. H. Haynes. 1897.
32	S. E. Burgess. 1899.

Transactions of Other Societies, Books, Etc.

(Not available for loan.)

London Chamber of Commerce. Report on Cement Admixtures. 1897. (13.)
Drainage Problems of the East (2 vols.). By C. C. James. (26.)
Field Work and Instruments. By A. T. Walmisley. (14.)
Glasgow Engineering Congress, Section VII. (Municipal), 1901.
Institution of Mechanical Engineers.
Land Surveying and Levelling. By A. T. Walmisley. (15.)
Land Treatment of Sewage. By H. T. Scoble. (31.)
Roads, Construction and Maintenance. By A. Greenwell. (27.)
Sanitary Fittings and Plumbing. By G. L. Sutcliffe. (30.)
Sewerage and Sewage Disposal. By Prof. H. Robinson. (28.)
Sewage Disposal. By Prof. H. Robinson. (29.)
Society of Engineers.
Surveying Instruments. By W. F. Stanley. (16.)
The Sanitary Institute.

Special Reports.

(Not available for loan.)

Bacterial Treatment of Sewage. Prof. Frank Clowes, D.Sc. (London), and A. C. Houston, M.B., D.Sc. 1904. (1.)
Bacteriological Experiments with Sewage. Borough Surveyor, Leicester. 1900. (2.)
British Standard Sections. Engineering Standards Committee. 1903. (3.)
Manchester Main Drainage, Report on. City Surveyor, Manchester. 1896. (4.)
Public Baths, Instructions, etc., to Architects. Surveyor to the Urban District Council, Handsworth. 1901. (5.)
Sewage Disposal, Report on. Borough Surveyor, Bradford. 1896. (6.)
Sewage Disposal Works, Specification, etc., for. Borough Engineer, Blackburn. 1893. (7.)
Sewage Purification. J. D. Watson. 1903. (8.)
Sewer Ventilation, Report on. Borough Engineer, Leicester. 1899. (9.)
Tramway Traction. City Surveyor, Birmingham. 1899. (21.)
—— City Surveyor, Sheffield. 1897. (10.)

Well Sinking and Boring Operations. Surveyor to the Urban District Council, Handsworth. 1904. (11.)

Western Australian Hard Woods. Agent-General for Western Australia. 1902. (12.)

Pamphlets.

(*Not available for loan.*)

Conical Projection of Maps. R. H. Foy. 1901. (17.)

Destructors and Steam Production. W. H. Maxwell. 1901. (18.)

Formulæ and Tables of Velocities and Discharges of Sewers. T. De Courcy Meade. 1897. (19.)

Hodograph, the. T. Ferguson. 1901. (20.)

Meteorology of Nottingham. Also Chart showing the relation of the Number of Deaths from various causes to Meteorological Conditions. (23.)

Municipal Subways. R. M. Parkinson. 1903. (24.)

Type Drawings for Melbourne Sewerage. W. Thwaites, Chief Engineer, Melbourne. (22.)

Journals.

(*Not available for loan.*)

American Electrician.
,, Electrical World and Engineer.
,, Engineering Record.
Builder.
Cassier's Magazine.
Contract Journal.
Electrical Engineer.
Engineering Times.
Local Government Chronicle.
Local Government Officer.
Page's Magazine.
Sanitary Record.
Street Railway Journal.
Surveyor and Municipal and County Engineer.
The Quarry.
Water.

EXAMINATIONS.

SYLLABUS.

The Incorporated Association of Municipal and County Engineers undertake the holding of Examinations, by written papers and *vivâ voce*, in the following subjects:—

Engineering as applied to Municipal work. (Two papers.)
Building Construction and Materials.
Sanitary Science as applied to Towns and Buildings.
Municipal and Local Government Law as relating to the work of Municipal Engineers and Surveyors.

Every candidate who applies for permission to sit for the Examination of the Association must be at least 22 years of age, and must possess one of the Certificates hereinafter mentioned in each of the following subjects:—

English, including (1) English Composition; (2) English Grammar, including Analysis and Parsing; (3) English History; (4) Geography.

Mathematics, including (1) *Arithmetic*—Vulgar and decimal fractions, proportion, square root, simple and compound interest, profit and loss, percentage, H.C.F. and L.C.M.; (2) *Algebra*—the ordinary rules; fractions; brackets; simple, simultaneous and easy quadratic equations, and problems involving the use of such equations; H.C.F.; L.C.M.; and square root; (3) *Euclid*—the first three books.

List of Certificates which will be accepted as evidence that Candidates possess the necessary qualifications in the various subjects:—

(1) English Composition and (2) English Grammar.

University of London: Matriculation Examination.
Victoria University: Preliminary Examination.
University of St. Andrews: Preliminary Examination in Science.
University of Glasgow: Preliminary Examination in Science.
University of Aberdeen: Preliminary Examination in Science.
University of Edinburgh: Preliminary Examination in Science.
University of Dublin: General Examination at end of Senior Freshman year.

University of Wales: Matriculation Examination.

University of Birmingham: Matriculation Examination.

King's College, London: Examination for the College Matriculation Certificate in Engineering.

University College, London: Matriculation Examination (Engineering Department).

Royal Indian Engineering College, Cooper's Hill: Entrance Examination.

City and Guilds of London Central Technical College: Matriculation Examination.

University College, Bristol: Preliminary Examination (Engineering Department).

Scotch Education Department: The Leaving Certificate.

Oxford and Cambridge Schools Examination Board: A Higher Certificate.

University of Adelaide: Senior Public Examination.

University of Tasmania: Senior Public Examination.

Central Welsh Board: Honours, Senior or Junior. Certificate to be endorsed "English Composition," "English Language," and "English Literature."

Oxford Local: Senior Examination—Honours or Pass. Junior Examination—Honours or Pass. *Cambridge Local*: Senior Examination—Honours or Pass. Junior Examination—Honours or Pass.	Certificate for English Language and Literature will be accepted as qualification required in English Composition and English Grammar.

Society of Arts: Advanced stage—First or Second Class, obtained since 1904; Intermediate stage—First Class, obtained since 1904; and the certificates corresponding thereto obtained prior to 1904.

College of Preceptors: First Class (or Senior), Second Class (or Junior), in the Professional Preliminary Examination; First Class (or Senior), Second Class (or Junior), in Certificate Examination.

(3) English History.

University of London: Matriculation Examination.

Victoria University: Preliminary Examination.

University of St. Andrews: Preliminary Examination in Science.

University of Glasgow: Preliminary Examination in Science.

University of Aberdeen: Preliminary Examination in Science.

University of Edinburgh: Preliminary Examination in Science.

University of Dublin: General Examination at end of Senior Freshman year.

University of Wales: Matriculation Examination.

University of Birmingham: Matriculation Examination.

King's College, London: Examination for the College Matriculation Certificate in Engineering.

University College, London: Matriculation Examination (Engineering Department).

Royal Indian Engineering College, Cooper's Hill: Entrance Examination.

City and Guilds of London Central Technical College: Matriculation Examination.

University College, Bristol: Preliminary Examination (Engineering Department).

Scotch Education Department: The Leaving Certificate.

Oxford and Cambridge Schools Examination Board: A Higher Certificate.

University of Adelaide: Senior Public Examination.
University of Tasmania: Senior Public Examination.
Central Welsh Board: Honours, Senior or Junior.
Oxford Local: As for English Composition and English Grammar. Certificate for History will be accepted as qualification required in English History.
Cambridge Local: As for English Composition and English Grammar. Certificate (Senior or Junior) for History, Geography, etc., will be accepted as qualification required in English History and Geography.
Society of Arts: As for English Composition and English Grammar. Certificate for Commercial History and Geography will be accepted as qualification required in English History and Geography.
College of Preceptors: As for English Composition and English Grammar.

(4) Geography.

University of London: Matriculation Examination.
Victoria University: Preliminary Examination.
University of St. Andrews: Preliminary Examination in Science.
University of Glasgow: Preliminary Examination in Science.
University of Aberdeen: Preliminary Examination in Science.
University of Edinburgh: Preliminary Examination in Science.
University of Dublin: General Examination at end of Senior Freshman year.
University of Wales: Matriculation Examination.
University of Birmingham: Matriculation Examination.
King's College, London: Examination for the College Matriculation Certificate in Engineering.
University College, London: Matriculation Examination (Engineering Department).
Royal Indian Engineering College, Cooper's Hill: Entrance Examination.
City and Guilds of London Central Technical College: Matriculation Examination.
University College, Bristol: Preliminary Examination (Engineering Department).
Scotch Education Department: The Leaving Certificate.
Oxford and Cambridge Schools Examination Board: A Higher Certificate.
University of Adelaide: Senior Public Examination.
University of Tasmania: Senior Public Examination.
Central Welsh Board: Honours, Senior or Junior.
Oxford Local: As for English Composition and English Grammar.
Cambridge Local: As for English History.
Society of Arts: As for English History.
College of Preceptors: As for English Composition and English Grammar.

Mathematics.

University of London: Matriculation Examination.
Victoria University: Preliminary Examination.
University of St. Andrews: Preliminary Examination in Science.
University of Glasgow: Preliminary Examination in Science.
University of Aberdeen: Preliminary Examination in Science.
University of Edinburgh: Preliminary Examination in Science.
University of Dublin: General Examination at end of Senior Freshman year.

University of Wales: Matriculation Examination.

University of Birmingham: Matriculation Examination.

King's College, London: Examination for the College Matriculation Certificate in Engineering.

University College, London: Matriculation Examination (Engineering Department).

Royal Indian Engineering College, Cooper's Hill: Entrance Examination.

City and Guilds of London Central Technical College: Matriculation Examination.

University College, Bristol: Preliminary Examination (Engineering Department).

Scotch Education Department: The Leaving Certificate.

Oxford and Cambridge Schools Examination Board: A Higher Certificate.

University of Adelaide: Senior Public Examination.

University of Tasmania: Senior Public Examination.

Central Welsh Board: Honours, Senior or Junior. Certificate to be endorsed "Arithmetic," "Algebra," and "Geometry."

Oxford Local: As for English Composition and English Grammar. Certificate to be endorsed "Arithmetic" and "Mathematics."

Cambridge Local: As for English Composition and English Grammar. Certificate to be endorsed "Arithmetic" and "Mathematics."

College of Preceptors: As for English Composition and English Grammar. Certificate to be endorsed "Arithmetic," "Algebra," and "Geometry."

Board of Education: Science Examination—Stage 1, First Class; or Stages 2 and 3, any Class.

The foregoing regulations do not apply to Candidates who have previously sat or received permission to sit.

A Candidate who has been awarded any of the undermentioned Certificates is exempt from further educational examination: The Institution of Civil Engineers, Studentship; The Royal Institute of British Architects, Preliminary; the Surveyors' Institution, Preliminary.

The Council reserve power to alter or add to the foregoing requirements.

Two or more Examinations are held in each year, one at least, in April, in London, and one at least, in October, in some provincial town to be fixed on by the Council and duly advertised beforehand.

Examinations will also be held in Scotland and Ireland, providing a sufficient number of Candidates desire to enter. Examinations in Scotland will be held in October; in Ireland, in April.

The Council will consider applications, which must be made on the form issued with the syllabus.

If permission is granted by the Council, a "sitting" form will be forwarded. The candidate may then make application on such form to be entered for the next ensuing, or any future, examination.

Candidates who have sat and failed, are particularly requested

to ask for a "sitting" form, when they desire to enter their names for re-examination.

The Council will accept entries, in order of priority, as far as accommodation will permit.

The fee for each Examination is *4l. 4s.*, two guineas to be paid with the "sitting" form, and two guineas on the day of examination.

The fee is to be sent with the sitting form ONLY.

Candidates who do not present themselves for examination forfeit their entrance fee.

A candidate sitting for examination *after* October 1907, and failing to satisfy the examiners in *not more than two* of the five subjects, will be permitted to sit at any subsequent examination, on payment of half-fees, for re-examination only in the subject or subjects in which he failed. Upon completing his passes in all the five subjects, he will be duly granted the testamur of the Association.

A candidate failing in *more* than two subjects will be permitted to sit, for re-examination in all the subjects, at any subsequent examination, on payment of half-fees.

The Examinations occupy three days, and the subjects are taken as follows:—

First day,	10 to 1 ..	..	Sanitary Science.
„	2.30 to 6.30	..	Building Construction.
Second day,	10 to 1 ..	..	Engineering (1st Paper).
„	2.30 to 6	..	„ (2nd „).
Third day,	9.30 to 11.30	..	Municipal and Local Government Law.
„	12	..	*Vivâ voce* Examination.

Candidates must attempt one question in each section, but must not attempt more than six questions in each subject. In the case of Municipal Law, which is not divided into sections, not more than six questions must be attempted.

Successful candidates receive a Certificate in the form of a "Testamur," signed by the acting Examiners, and sealed and countersigned by the President and Secretary of the Association in Council.

No information as to the result of an Examination, beyond the fact of a candidate having "Passed" or "Failed," is given.

Questions set at Examinations held prior to 1902 can only be obtained in the volumes of the 'Proceedings.' On sale by Messrs. E. & F. N. SPON, Ltd., Publishers, 57 Haymarket, S.W. The questions set at subsequent examinations are not published.

Any inquiries referring to the Examinations should be directed to Mr. THOMAS COLE, Secretary to the Association, 11 Victoria Street, London, S.W., and should be accompanied by an addressed foolscap envelope.

SUBJECTS OF EXAMINATION.

I.—Engineering as applied to Municipal Work: 1st Paper:

A. Sewage Disposal.
B. Tramways Construction.
C. Bridge Construction.
D. Water Supply.

II.—Engineering as applied to Municipal Work: 2nd Paper:

A. Geodesy.
B. Hydraulics.
C. Sewerage.
D. Road Construction and Maintenance.

III.—Building Construction: Strength of Materials:

A. Materials.
B. The Construction of Public and Private Buildings.
C. Building By-laws.
D. Public Baths and Hospitals.

IV.—Sanitary Science as applied to Towns and Buildings:

A. Heating and Ventilation.
B. Scavenging and Disposal of Refuse.
C. Water Supply and Drainage of Buildings.
D. Disinfection.

V.—Municipal and Local Government Law as relating to the Work of Municipal Engineers and Surveyors.

Note.—The Examiners do not recommend any particular text-books, as it is desired to make the Examinations rather a test of the candidate's practical knowledge of the subjects generally, than to find his acquaintance with any particular book or books.

EXAMPLES OF QUESTIONS.

The following questions have been compiled from Examination Papers set to Candidates, and serve as examples of the questions asked under the different sections.

DIRECTIONS.—"You are particularly requested to write legibly, and to answer the questions as concisely as possible. *Fill in your number where indicated, also at the top of every book handed in. Prefix the number of the question to each answer. Place this question-paper inside your book before handing it in.* Wherever possible, freehand sketches or diagrams should be drawn to illustrate the answer; these should be carefully executed, as they will be taken as showing the Candidate's proficiency in this style of drawing. Candidates must not, during the examination, refer to any books or manuscript, or communicate with each other. Slide rules may not be used."

I. SUBJECT:—ENGINEERING AS APPLIED TO MUNICIPAL WORK.

(Candidates must attempt one question in each section, but not more than six in all.)

FIRST PAPER.

(*Time allowed*, 3 *hours*.)

SECTION A. SEWAGE DISPOSAL.

1. Describe briefly the various systems of treatment now in use at outfall works, explain their general principles, advantages, and disadvantages.

2. Describe an up-to-date system of sewage disposal suitable for a district of 10,000 population, taking a dry-weather flow of 40 gallons per head per day, and state how you would deal with storm water. Give dimensions wherever possible.

3. A series of settling tanks are to be constructed, each to contain 250,000 gallons. State the dimensions you suggest for one of such tanks, and give sketch, plan and sections showing the form of bottom you suggest, and the position of inlets and outlets, and how same should be formed.

SECTION B. TRAMWAYS CONSTRUCTION.

4. Sketch and describe the various kinds of tramway rail joints in use for electric traction, stating their respective advantages and disadvantages. Design an ordinary fish-plate joint, and point out the features to which you consider special attention should be paid.

5. Sketch the cross section of a road 32 ft. wide between kerbs, one side being 1 ft. lower than the other, with double track tramway, 3 ft. 6 in. gauge; show, in figures, the "cambering" of the road, when paved the whole width with stone setts, or Jarrah wood, and also when the tramway is paved with setts, and the remainder of the road macadam.

6. Sketch a "turn out" or "passing place" on a single line of tramway, figure the leading dimensions, the angle of the crossings, and describe the length, position and character of the "points" required for diverting the traffic.

Section C. BRIDGE CONSTRUCTION.

7. Work out the strains on a wrought iron girder (sketch given) 56 ft. span, 7 ft. high, and give figured sections of flanges, struts and ties. Distributed load 200 tons.

8. State the live load per foot run of paths and carriageway you would allow for in the case of a bridge, 60-ft. span, with a carriageway 36 ft. wide, and 12-ft. paths on each side.

   The bridge has two lines of tramway, 4 ft. 8½ in. gauge, to carry cars weighing 5 tons when loaded, the distance between the two wheel axles being 18 ft.

9. A bridge has to be constructed to carry a 60-ft. street over a canal, the clear span being 40 ft., the minimum head room being 11 ft. at centre and 9 ft. at sides above normal water level: the approaches are rising gradients of 1 in 24 and 1 in 90 respectively. Sketch the bridge you recommend for such a position, giving all important particulars, short specification tests for materials, and tests for bridge when completed.

Section D. WATER SUPPLY.

10. What percentage of total annual rainfall over a watershed would you expect to have available for storage? State locality and characteristics of the watershed to which your answer relates.

11. A covered reservoir is required to serve a town of 5000 inhabitants. Sketch and describe the reservoir you would adopt, giving all requisite details, and assuming your own conditions of site and foundation. Give a short specification of the necessary works, tests for materials, and an estimate of cost.

12. Sketch and describe a small pumping station capable of lifting daily 100,000 gallons of water from a borehole in the rock and delivering through a rising main 500 yards long into a reservoir, the total vertical lift being 100 ft. After working out the theoretical horse power required, state the brake-horse power and type of engine you recommend, and give your reasons.

II. Subject:—ENGINEERING as applied to Municipal Work.

(Candidates must attempt one question in each section, but not more than six in all.)

SECOND PAPER.

(*Time allowed*, $3\frac{1}{2}$ *hours.*)

Section A. GEODESY.

1. Describe the mode of making a land survey with the chain only, and with the usual instruments, and explain the advantages of the latter method. Describe the instruments, and give an illustration of a "field-book" with imaginary entries therein.

2. Make a sketch of the primary and vernier scales of a theodolite for reading to minutes. Explain the object of the vernier, and the principle upon which it works.

3. How would you proceed to contour and make a plan of a valley proposed to be used as an impounding reservoir? What is the advantage of a contour plan for this purpose?

Section B. HYDRAULICS.

4. The velocity in a 9-in. pipe, running full, laid at a gradient of 1 in 48, is 352 ft. per minute. Give the velocities in such a pipe when laid at the following gradients: 1 in 16, 1 in 96, and 1 in 432.

5. A pumping main a mile in length is required to discharge 600 gallons per minute at a velocity of 3 ft. per second. What diameter pipe is necessary?

6. What do you mean by "hydraulic mean depth"? Why is the hydraulic mean depth the same in the case of a circular pipe flowing full or half full, supposing you agree that it is so?

Section C. SEWERAGE.

7. Describe the usual method of setting out the lines for the construction of a sewer, and the means that should be adopted to ensure that the invert shall be laid to the correct depth and gradient.

8. Make a detail sketch with figured dimensions of a storm overflow chamber on a 3 ft. by 2 ft. egg-shaped sewer, discharging when full 600 cubic ft. per minute, assuming that the storm overflow will come into operation when the sewage flowing is one-third the depth of the sewer.

9. A circular sewer, 4 ft. internal diameter, is to be constructed with brickwork in open cutting, the invert being 15 ft. below the surface of the ground. Trial holes show 6 ft. of loose made ground, 4 ft. of clay, and 12 ft. of running sand resting on a thick bed of clay. Show by sketches the timbering of the trench and the construction of the sewer, and give a description of the work and materials.

Section D. ROAD CONSTRUCTION AND MAINTENANCE.

10. Do you consider the stones in macadam should be all of one gauge, or do you prefer varying sizes? State the reasons for your preference.

11. A macadamised carriageway 36 ft. wide has got into bad repair, and the whole surface requires to be recoated with stone for an average thickness of 3 in. Explain in detail the different operations necessary to carry out the repairs, including rolling, and give the cost per yard of each operation, assuming that the cost of the stone delivered on the road is 12*s*. 6*d*. per ton, binding material 3*s*. 6*d*. per ton, and labour 5*d*. per hour.

12. Give a brief description and express your opinion of any methods of road construction and treatment with which you are familiar for the prevention of dust caused by motor traffic.

III. Subject:—BUILDING CONSTRUCTION.

(Candidates must attempt one question in each section, but not more than six in all.)

(*Time allowed, 4 hours.*)

Section A. MATERIALS.

1. State what you know of the various timbers used in building, and what class of work and situation they are each adapted for.

2. State the crushing and safe working loads of any brickwork with which you are acquainted, describing the brickwork.

3. Explain, as far as you can, the different characteristics and chemical composition of common lime, hydraulic lime, Roman cement, Portland cement, and Keene's cement.

Section B. THE CONSTRUCTION OF PUBLIC AND PRIVATE BUILDINGS.

4. A girder, with a clear span of 30 ft., bears a uniformly distributed load of 40 tons; it is supported at one end by a wall and at the other by a hollow cast-iron column, circular in section. The column is 10 ft. in height with fixed ends. Give the dimensions of the column with method of calculation.

5. In the construction of a factory chimney specify the following:—
   (*a*) The subsoil being a stiff clay and weight of shaft 1000 tons, what area of concrete is it necessary to provide for foundation?
   (*b*) What proportion should the spread of the footings bear to the thickness of the brickwork at the base of the shaft?
   (*c*) In a shaft 200 ft. high, give the varying thickness of brickwork from base to cap, with distances between the various offsets and height of fire-brick lining.
   (*d*) What is the usual proportion of the diameter of base to the height of shaft (circular on plan)?
   (*e*) State the comparative advantages of circular, octagonal and square shafts with regard to wind resistance.
6. Sketch a concrete beam reinforced with steel rods to carry a distributed dead load of 20 tons with a clear span of 15 ft. Show your calculations.

Section C. BUILDING BY-LAWS.

7. State how the subsoil of the site of an intended new building should be drained, "where the dampness of the site renders such precaution necessary." Give sketch plan of drains.
8. Describe fully the chief provisions for the prevention of the spread of fire from one house to another.
9. What information must be given to a sanitary authority by a person desirous of laying out a new street?

Section D. PUBLIC BATHS AND HOSPITALS.

10. Make a cross-sectional sketch of a public swimming bath, 44 ft. in width over all, showing the bath, dressing boxes, gallery, and roof, with their several dimensions. Describe fully the means adopted for rendering the bath water-tight, and give the type of roof.
11. In designing an isolation hospital for 100 beds, shortly describe the following provisions, viz.:—
    Number and extent of ward blocks.
    Nature of other buildings necessary for administration purposes.
    Proportion of floor space per bed.
    Proportion of cubical space per bed.
    Method of ventilation to be adopted in wards.
    Method of heating to be adopted in wards.
12. In designing public baths, comprising, say, a swimming bath 70 ft. × 30 ft., ten slipper baths, and a small laundry, what method would you adopt to heat the water and how would you warm the building?

IV. SUBJECT:—SANITARY SCIENCE AS APPLIED TO TOWNS AND BUILDINGS.

(Candidates must attempt one question in each section, but not more than six in all.)

(Time allowed, 3 hours.)

SECTION A. HEATING AND VENTILATION.

1. Explain what you mean by "natural" and "artificial" ventilation. Illustrate your answer by sketches of each as applied to a public building or school. What are the advantages and disadvantages of each system?
2. In preparing a scheme for warming a building, what are the recognised methods of calculating the amount of heating surface required for varying temperatures?
3. Describe concisely three different methods of ventilating sewers, expressing your views as to their merits or otherwise.

SECTION B. SCAVENGING AND DISPOSAL OF REFUSE.

4. Describe the method you would adopt for collecting—
   (a) The contents of cesspools.
   (b) Excreta in pails.
   (c) Offal.

   And give particulars of the vehicle you would recommend in each case.
5. Describe the essential features of a good type of refuse destructor, and give a section of the same.
6. Describe the most satisfactory means of
   (a) Removing house refuse
   (b) Cleansing ashpits and privies

   where the local authority undertake the work of removal.

SECTION C. WATER SUPPLY AND DRAINAGE OF BUILDINGS.

7. Describe the construction of a hot-water service for bath and other purposes in a house. Describe how the circulation is obtained, and show, by a diagram, the position of the boiler, cistern, cylinder, etc., and state the precautions that should be taken to prevent damage by frost.
8. State shortly what are the general principles of efficient house drainage, and give a few examples of how these are frequently disregarded in actual practice.
9. What kind of water acts upon lead? State the risk attendant upon its use and the means you would adopt for avoiding or reducing such risk.

Section D. DISINFECTION.

10. Mention the various disinfectants in common use, and state which you consider the best for particular purposes. Describe the methods of use and the precautions necessary.

11. What are the points to be observed in the selection of the necessary apparatus to effect the proper disinfection of bedding and clothing? Give a brief description of the apparatus with which you are acquainted.

12. Describe how you would proceed to disinfect a house after the following diseases: (*a*) scarlet fever, (*b*) typhoid fever, (*c*) diphtheria, (*d*) small-pox.

V. Subject:—MUNICIPAL AND LOCAL GOVERNMENT LAW as relating to the Work of Municipal and County Engineers and Surveyors.

(Candidates must not attempt more than six questions.)
(*Time allowed*, 2 *hours*.)

(England)

1. Under what Act can a local authority make bye-laws as to deposit of plans for alterations to existing buildings, and to what buildings do these bye-laws apply?

2. What are the conditions under which a manufacturer may discharge his trade refuse into the sewers of a local authority?

3. Can a local authority compel a proper supply of water to be laid on to premises, and if so, under what conditions in (*a*) urban districts, (*b*) rural districts? State the mode of procedure in each case.

4. The surveyor to a local authority has reported to him (*a*) a dangerous building abutting on a public highway, and (*b*) a dangerous chimney on private enclosed premises. State what are his powers and duties in each case, and set out fully the proceedings he would take in proper sequence.

5. An occupier refuses to allow his premises to be entered by the assistants of the surveyor to a local authority for the purpose of taking levels; what course is prescribed by statute to meet such a case?

6. State which Acts give powers respecting tramways and light railways, and describe the principal differences between them, particularly as to position of tramway in road, spaces, notices, supervision, and mode of procedure.

7. Describe the provisions of the Buildings in Streets Acts, 1888, and point out in what respect they differ from the previously existing powers.

8. What rights have owners and occupiers of property to connect their drainage with the sewers of a local authority (*a*) within the district, (*b*) without the district, (*c*) under what restrictions can the connections be made, and (*d*) what are the penalties for non-compliance?

9. Give two instances where you consider the present Public Health and Sanitary Acts or Highways Acts are defective or require amendment, and in what way would you remedy these defects?

   This question is intended to elicit answers from candidates as to any difficulties they may have experienced or observed or heard of in carrying out the duties of a surveyor.

10. What is a Provisional Order, and when is it usually applied for? Compare it with a local Act of Parliament, specifying its chief advantages. State the nature of Provisional Orders issued by the Board of Trade as distinct from the Local Government Board.

11. Give reasons for recommending a council to adopt the Private Streets Works Act, 1892. State also the disadvantages of that Act compared with sections 150 and 152 of the Public Health Act, 1875.

12. What powers have local authorities with respect to—
    (*a*) Planting of trees in highways?
    (*b*) Underground conveniences?
    (*c*) Sanitary conveniences for manufactories?
    (*d*) Ingress to and egress from places of public resort?
    (*e*) Safety of platforms on public occasions?

V. MUNICIPAL AND LOCAL GOVERNMENT LAW AS RELATING TO THE WORK OF MUNICIPAL ENGINEERS AND SURVEYORS.

(Candidates must not attempt more than six questions.)

(*Time allowed, 2 hours.*)

(Scotland)

1. Define the various roads to which these words apply, viz., Highway, Turnpike Road, Statute Labour Road, as interpreted by the Roads and Bridges (Scotland) Act, 1878.

2. Describe the statutory provisions whereby a local authority can recover from any person expenses for damage to highways caused by extraordinary traffic thereon, or by excessive weight passing along the same; and state in what Act of Parliament these provisions are embraced.

3. To whom must application be made for authority to lay out new streets? Specify the details which require to be shown on the plan accompanying the application.

4. If a Burgh should desire to improve any existing private streets, what statutory procedure would be necessary?

5. What are the powers of a Burgh with reference to the keeping of footpaths of public streets in proper repair? How far do these powers apply to private streets?

6. Specify the procedure which must be adopted in a Police Burgh before a public sewer can be laid. Under what Act is this necessary?
7. What powers of entry are given under the Public Health (Scotland) Act for the purpose of examining drains, and what is the necessary procedure?
8. Specify the duty of a Local Authority with reference to the water supply of buildings in an isolated district.
9. Enumerate the powers given for the formation of special water supply districts. State briefly under what circumstances a Local Authority is bound to take action.
10. What were the requirements of the 1892 Burgh Police (Scotland) Act with regard to back space for proposed buildings, and what alteration was made by the 1903 Act?

BOARD OF EXAMINERS.

The President of the Association (*ex-officio*).

Lewis Angell, M. Inst. C.E., F.R.I.B.A., Fellow of King's College, London
J. P. Barber, M. Inst. C.E.
W. Nisbet Blair, M. Inst. C.E.
J. A. Brodie, M. Eng., Wh. Sc., M. Inst. C.E.
C. Brownridge, M. Inst. C.E.
J. Bryce, A.M. Inst. C.E.
J. Cockrill, M. Inst. C.E.
A. E. Collins, M. Inst. C.E.
C. H. Cooper, M. Inst. C.E.
H. A. Cutler, M. Inst. C.E.
A. T. Davis, M. Inst. C.E.
R. H. Dorman, M. Inst. C.E.
W. Dyack, M. Inst. C.E.
J. T. Eayrs, M. Inst. C.E.
A. M. Fowler, M. Inst. C.E.
A. D. Greatorex, M. Inst. C.E.
G. Green, A.M. Inst. C.E.
S. Harty, M. Inst. C.E. I.
R. H. Haynes, M. Inst. C.E.
C. Jones, M. Inst. C.E.
James Lee
James Lemon, M. Inst. C.E., F.R.I.B.A.
Jos. Lobley, M. Inst. C.E.
A. B. McDonald, M. Inst. C.E.
E. G. Mawbey, M. Inst. C.E.
C. J. Mulvany, M. Inst. C.E., B.A. I. (Dublin).
James Paton.
J. S. Pickering, M. Inst. C.E.
W. H. Prescott, A.M.Inst. C.E.
R. Read, A.M. Inst. C.E.
O. C. Robson, M. Inst. C.E.
H. E. Stilgoe, M. Inst. C.E.
R. J. Thomas, M. Inst. C.E.
H. T. Wakelam, M. Inst. C.E.
W. Weaver, M. Inst. C.E.
A. E. White, M. Inst. C.E.
C. F. Wike, M. Inst. C.E.
T. H. Yabbicom, M. Inst. C.E.

CANDIDATES WHO PASSED THE EXAMINATIONS HELD 1906–1907.

55*th and* 56*th Examinations*, *October* 1906.

H. J. Amoore.
G. H. Bell.
E. A. Borg.
F. S. Clarkson.
R. H. Couzens.
W. J. Dunning.
J. H. Edwards.
W. H. Goldsmith.
A. C. Hewitt.
A. C. Hodge.
C. F. Hunt.
W. R. Jenkins.
F. C. Jenkinson.
T. Jones.
R. B. Lees.
R. H. Matthews.
E. Parker.
H. Pool.
C. H. Sunderland.

57*th and* 58*th Examinations*, *April* 1907.

A. G. Andrews.
C. W. Annis.
T. B. Ball.
W. H. Budgett.
R. Chart, junr.
W. C. Clemens.
H. B. Crossley.
J. W. Croxford.
E. Edwards.
B. Ellis.
W. A. Harrison.
W. H. Johnson.
F. E. Jones.
G. R. King.
N. P. Laird.
A. E. Loach.
H. E. Ollevant.
G. B. R. Pimm.
H. E. Pollard.
F. Stanyer.
G. W. Teasdale.
F. Thackray.
E. Thomas.
N. G. Tomey.
W. J. W. Westlake.
A. G. Wheeler.

Memoirs of Deceased Members.

THE Council, having been requested to append some short notice of the decease of Members of the Association, will feel obliged by early notice being forwarded to the Secretary, with such particulars as it may be desirable to insert in these "Proceedings."

Mr. FRANCIS J. C. MAY, who died on July 7, 1906, was born on July 2, 1839. He was educated at a private classical school at Islington, of which the Rev. George Darnall, M.A., was principal. He was afterwards articled to the late Mr. Richard Alchin, one of the partners in the firm of Messrs. W. Cubitt and Co., where he gained a wide experience of architectural, engineering, and building work. In 1872 he was appointed Surveyor to the Malling Highway Board, Kent, and subsequently Engineer and Surveyor to the Malling Rural Sanitary Authority, two separate and distinct areas. The duties of this dual appointment included the carrying out of some important schemes, such as the drainage of the parishes of West Malling, Wateringbury, and Snodland. Some of the most important roads in the county were under his care, and by his skilful management he became a recognised authority on the art and practice of road making. In 1882 Mr. May was appointed Borough Surveyor of Maidstone and in 1889 Borough Engineer of Brighton. There he designed and carried out many important works, including those of sea defence, extension of the main sewers, the free library, art galleries, and a scheme for enlarging and remodelling the town hall. Mr. May was President of the Association 1906–7. He was first elected on the Council in 1894, and was the first past president to be re-elected on the Council by ballot of the members. He was elected a Member of the Association in May, 1875.

Mr. JONATHAN HAIGH, who died on July 23, 1906, was born at Wakefield (Yorkshire) on February 21, 1853. In 1868 he entered the engineering works of Messrs. Edward Green and Sons, Wakefield, where he spent three years. From 1871 to 1874 he served three years as articled pupil to the late Mr. William Crutchley, Civil Engineer and Architect, of Wakefield, continuing as Engineering and Architectural Assistant to Mr. Crutchley until January 1875. For a short period of the year 1875 he was employed as Architectural Assistant to the late Mr. William Dawes, Architect, Manchester, whose service he left to become Managing Assistant to Mr. Chas. W. Richardson, Architect and Building Surveyor, of Leeds and Wakefield. In 1877 he became Assistant Engineer and Surveyor to the Aston Manor (Birmingham) Local Board, a post that he relinquished in 1880 to take up the appointment of Engineer and Surveyor to the Abergavenny Board of Improvement Commissioners, subsequently constituted an Urban District Council, and incorporated in 1899, when Mr. Haigh was appointed the first Borough and Waterworks Engineer, continuing actively in office until the day of his death. He was elected a Member of the Association in June, 1885.

Mr. RICHARD H. MIDDLETON, late Borough Surveyor of Walsall, died on August 4, 1906. He held a high position in his profession, and during his service under the Walsall Corporation carried out a number of important undertakings, including the construction of the corporation tramways—a work which was of considerable difficulty, owing to a portion of the track having to be laid on a road which had sunk through mining operations. The ability with which the whole scheme was completed received special recognition from the Town Council. Mr. Middleton was elected a Member of the Association in June, 1890.

Mr. T. LLOYD EDWARDS, late Surveyor to the Glamorgan County Council, died on August 7, 1906, in the 63rd year of his age. After serving his articles in the Great Western Railway works at Swindon, he became Surveyor to the Bangor Local Board, and was subsequently appointed Surveyor to the town of Aberdare. He held this post for some years with the greatest credit to himself and benefit to Aberdare. On

the formation of the Glamorganshire County Council he was appointed by that body Surveyor for that county. He supervised an immense amount of public improvements in the county, especially in the widening of the main roads, and was held in very high respect throughout the county. Mr. Edwards was elected a Member of the Association in April, 1898.

Mr. HUGH UNSWORTH McKIE, formerly City Surveyor, Carlisle, died on January 19, 1907, in his 85th year. He served his articles with Mr. Lamb at Hay Carr near Lancaster, and was afterwards in partnership with his previous fellow pupil, the late Mr. John Lawson. The late Mr. James Mansergh, Past President of the Institution of Civil Engineers, was a pupil of Mr. McKie, and subsequently a partner. Mr. McKie left Lancaster to carry out the main sewerage of Alnwick, where he first introduced the accepted system of laying sewers in straight lines from point to point. At Carlisle he designed and carried out the first sewage irrigation farm in England, on the completion of which he was made Engineer and Surveyor of that city. He left Carlisle to carry out the railway from Llandudno Junction to Bettws-y-coed. He then became actively engaged in North Wales and on the Continent for a number of years on many works, including the North Wales narrow-gauge railways, water, harbour, and other works. After carrying out the Southport main drainage work-he was again appointed City Engineer of Carlisle, where he carried out many important works. Mr. McKie left Carlisle in 1889, going into private practice at Westminster until his retirement from active life in 1898. He was highly esteemed by his contemporaries both for his great engineering abilities and his personal character. He was elected a Member of the Association in October, 1879.

Mr. JOHN NIXON HORSFIELD, late Surveyor to the Hampton Wick Urban District Council, died on February 10, 1907, at the age of 48, after a short illness extending over a week. He was educated at Owen's College, Manchester, and articled to an engineer of that city. In 1896 Mr. Horsfield was elected a member of the Kingston-on-Thames Corporation, an office he resigned after six years in consequence of his professional interest in tramway matters. For about ten years up to the

time of his death, he held the appointment of Surveyor to the Hampton Wick Council, and in addition he enjoyed an extensive private practice in which his two sons were partners, with offices at Westminster. Recently he had conferred upon him the honour of being made corresponding member of the Royal Society of Portuguese Architects. Mr. Horsfield was elected a Member of the Association in May, 1900.

Mr. John Smith, late County Surveyor for the East Riding of County Galway, died on February 15, 1907. Mr. Smith contracted a cold, which rapidly developed into pneumonia, and he succumbed after four days' illness. Mr. Smith was elected a Member of the Association in March, 1892.

Mr. George Hodson, formerly Surveyor to the Local Board of Loughborough, died on April 25, 1907, in his sixty-third year. He caught a chill, which developed into an acute attack of pleuro-pneumonia, death resulting after a fortnight's illness. Mr. Hodson was educated at Wolverhampton Grammar School. After the termination of his articles he was for a short time in the office of the Town Surveyor of Bilston, and Willenhall, and went to Loughborough in 1863. During the construction of the first waterworks at Loughborough by Messrs. James Simpson and Taylor, he acted as one of the resident engineers, and was afterwards appointed waterworks manager. Mr. Hodson made a special study of hydraulic and sanitary engineering, and as his practice grew he took into partnership his brother the late Mr. James F. Hodson. In 1881 he resigned the surveyorship. He designed and constructed waterworks and sewage works for more than sixty towns and districts. In his profession the deceased gentleman had been assisted for over twenty years by his eldest son Mr. F. Walter Hodson, who has been in partnership with him under the style of George and F. W. Hodson. The construction of the masonry dam recently completed of the Blackbrook Waterworks, Loughborough, was a gratification to him, and pleasure is very generally expressed that he lived to see the completion and opening of the works. Mr. Hodson, one of the founders, was elected a Member of the Association in February, 1873.